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The UNESCO Courier

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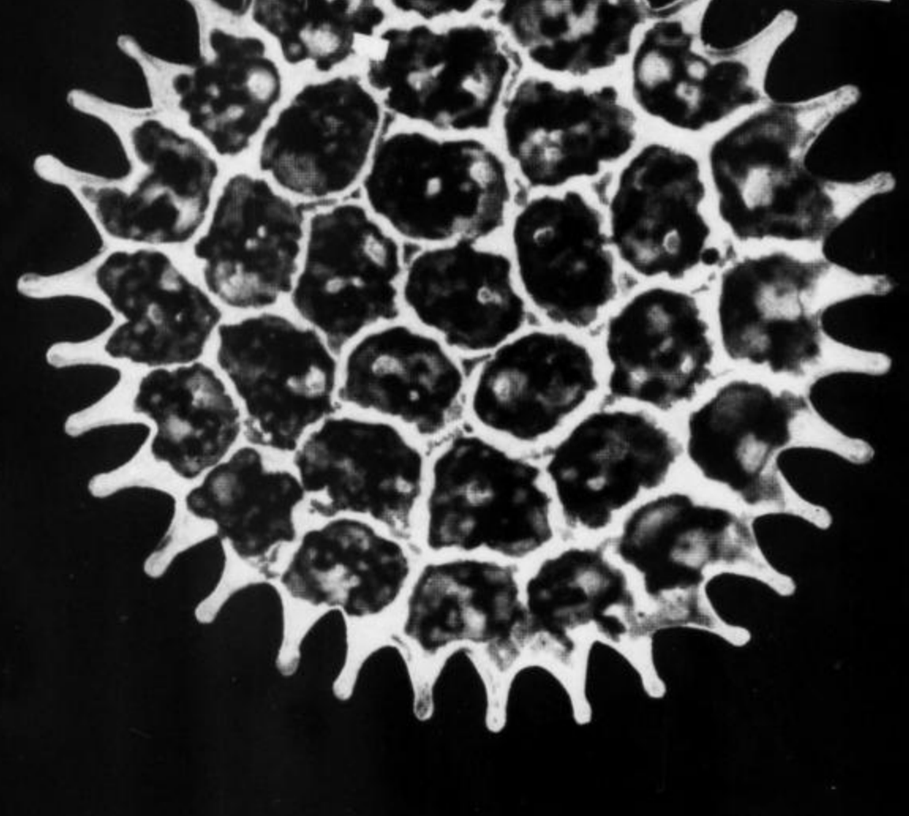
THE NEW FOOD REVOLUTION



TREASURES OF WORLD ART

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Nasredin the Sage—story telling with a smile

To the people of the Middle East the name Nasredin always invokes a chuckle—of admiration. Nasredin was a famous story teller-philosopher-jokester who lived in Anatolia during the 13th century—but who he actually was, where he came from and where he went remains a mystery. Turkey claims him as its national hero, in a sense so does Iran. There are those who say he never actually lived. But his anecdotes, mined from the rich vein of folk wisdom and always humorous, are more alive today than ever, from Turkestan to the Balkans and the eastern Mediterranean. Here, an 18th century Turkish miniature depicting Nasredin, the jovial philosopher-story teller.

Photo © Roland Michaud - Rapho

Nasredin and the moon

Little Nasredin was listening to his teacher reading a passage from the Koran : "God gave brilliance to the sun, and radiance to the moon".

— *Which is the more useful, the sun or the moon?* asked the teacher.

— *The moon,* replied Nasredin without a moment's hesitation.

— *And why is that?*

— *Because the sun only comes when it's daylight. But the moon lights up the world when it's dark.*

The old teacher sighed and deemed it wiser to return to the rules of grammar.

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Editorial Offices
Unesco, Place de Fontenoy, Paris 7e, France

Editor-in-Chief
Sandy Koffler

Assistant Editor-in-Chief
René Caloz

Assistant to the Editor-in-Chief
Lucio Attinelli

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Photo Editor: Olga Rödel

Layout and Design : Robert Jacquemin

All correspondence should be addressed to the Editor-in-Chief in Paris

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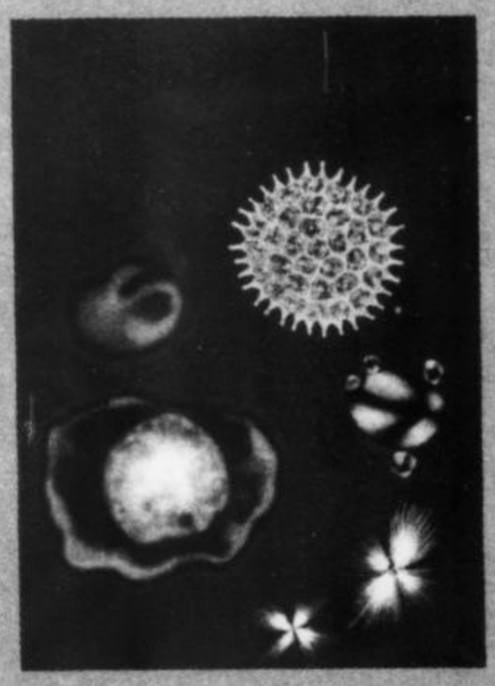

Cover photo

Along with the higher quality and more abundant harvests which science is helping the farmer to win from his fields, new foods are making their appearance on the market. Originally conceived and produced in scientific laboratories, these foods are "artificial" only in terms of the techniques used in their manufacture. They provide all the elements of a balanced diet, and in particular the vital proteins and amino acids. Photo shows various cells and other organisms as seen under the microscope.

Photos © J. L. Laporte, Paris

THE NEW FOOD REVOLUTION

by Gene Gregory

UNTIL relatively recently, all too few practical measures had been taken to come to grips with the problem of producing more food of the kind that was needed in the places it was needed most.

Much attention has been given to throttling, by medicinal or other artificial means, the population explosion —ironically enough, due largely in the first place to the introduction of modern medicine in less-developed countries. But one serious estimate, by the U.S. scientist and educator Harrison Brown in "The Challenge of Man's Future," holds that the earth could—with technology now within our reach—sustain a population of 50 thousand million, which even at the uncontrolled rate of present population growth would not be attained for four or five generations.

Since the evidence to date is that birth control methods simply are not working, and are not likely to be fully effective for another generation or two, more immediate solutions to the world's food problem must be sought elsewhere. Highest priority must be given to the expansion of food production, within each of the lesser-developed countries.

Food aid, while beneficial as a stop-gap measure to relieve famine caused by drought or flood, tends to attack the symptoms rather than the causes. While necessary in times of distress, even when food aid is maintained for a few years only, it breeds an unwholesome attitude of dependence among the recipients and makes it very difficult for local agriculture ever to get properly organized in face of competition from "free food."

GENE GREGORY *has made a close study of food manufacturing and processing, particularly in Asia. He is a chemical engineer, business consultant and journalist and was formerly editor-in-chief of the "Weekly Tribune", Geneva, Switzerland, and a member of the editorial board of "Asia Magazine", Hong Kong. He spent many years in South-East Asia where he was a foreign correspondent for Reuters Agency and held several editorial posts. He has written widely on economic and political questions.*

Even where shipments of agricultural goods have been used to generate local currencies which in turn become part of the overall funds available for economic aid programmes, those funds have too often been diverted into the development of new non-agriculture-related industries rather than improving and increasing food production.

The possession of a steel mill, a national airline and a polyethelene plant have been considered as symbols of progress—but were in fact monuments to the misconceived notion of planners that somehow these investments constituted a short cut to the solution of underdevelopment problems.

Even though as much as 80 per cent of the population of the less-developed countries is engaged in agricultural pursuits, according to a recent review of the Development Assistance Committee of the Organization for Economic Co-operation and Development (OECD), only 12 per cent of the total aid flow (including food aid) went to agriculture. As a result of misplaced emphasis on industrialization, agriculture was deprived of needed local investment inputs at all levels—irrigation, manufacture of fertilizers and pesticides, research, education, processing industries.

In a sense, the fearful spectre of a world food crisis was a blessing in disguise. There came a widespread recognition of the truth that while massive emergency food aid could alleviate much of the immediate suffering, a change of emphasis in foreign aid programmes was long overdue.

But perhaps even more important, the urgency of immediate action on the part of the governments of lesser-developed countries provoked a general up-grading of agricultural priorities for investments as well as a lifting of some of the impedimenta that have prevented private foreign capital from investing in industries for the manufacture of badly needed agricultural inputs and the processing of farm products for the home and export markets.

But, as yet, in the lesser-developed countries, all of them agricultural countries, there has been almost no agricultural research or higher agricultural education. Three exceptions are examples for all governments to imitate:

■ Mexico, which had for years imported half of the wheat consumed in the country, after an extensive wheat research programme begun in 1944 and conducted by the Rockefeller Foundation, was self-sufficient in this grain by 1956, and in 1964 exported a half million tons.

■ At Los Banos in the Philippines, research sponsored jointly by the Rockefeller and Ford Foundations developed new varieties of rice, the IR 5 and IR 8, which increase yields up to 8.5 tons per acre—or about 15 times the average yield of traditional varieties. As a result, in the short span of about three years the Philippines has been transformed from a rice deficit to a rice surplus country.

■ American aid agronomists adapted improved varieties of Guatemalan corns to Indonesia and Thailand which did, in fact, produce something of an agricultural revolution in the latter. In eight years the crop in Thailand increased from non-existent production to an export of $104 million, the fourth largest corn export in the world.

Extended to other critical food deficit areas, the results of these research efforts, largely privately financed, have produced a veritable "green revolution" in the world's most food deficient regions which just two years ago were threatened by widespread and seemingly continuing famine.

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Stout though badly cracked and patched, this grain elevator—symbol of the midwestern plains of North America—has a pattern that might have inspired certain works of modern abstract art.

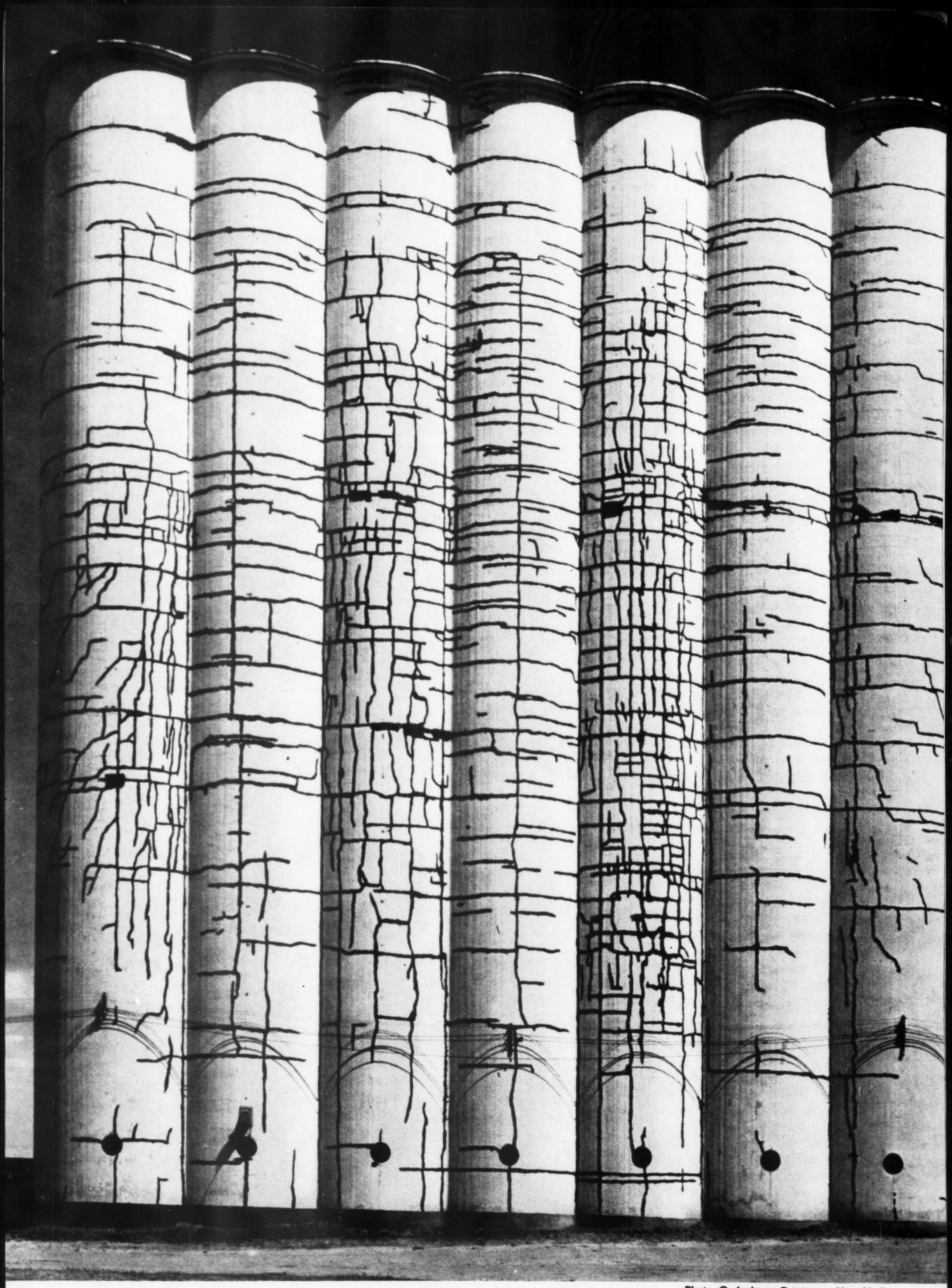


Photo © Andreas Feininger, New York

■ In India, the area planted with new varieties of wheat, rice, millet and sorghum increased from about 23,000 acres in 1965-66 to nearly 4 million acres one year later. As a result, India harvested 95.6 million tons in 1967-68, and expects to achieve self-sufficiency in 1970-71 (see text opposite).

■ Pakistan, which imported large quantities of Mexican wheat seed, will harvest a record 5.5 million ton grain crop this year; and by 1970 should be producing twice as much food grains as in 1965, enough to meet the country's requirements.

Particularly noteworthy results have been obtained by development teams of the Republic of China in African countries where they have introduced their Taiwan Native 1 rice species. Extensive experiments in the Cameroons, Gabon, Gambia, Malawi, Niger, Senegal, Chad and Togo by these teams have more than doubled production obtained with traditional rice strains.

As a result of these and other developments, farming has suddenly become both respectable and lucrative in many countries.

In Rome, early last October, Addeke H. Boerma, Director-General of FAO, expressed cautious optimism that "the long lag in food production which plagued the past decade may be coming to an end." And in Paris, he told delegates to a Unesco international scientific conference on the use and conservation of the resources of the biosphere, "I believe that the agriculture of the developing countries is now reaching the point of 'take-off'." (See the "Unesco Courier," January 1969.)

But the coming agricultural revolution is not confined to progress in the developing countries. New but untried ideas will displace a whole raft of outdated notions about food production—first in the advanced industrial countries, but eventually profoundly affecting the developing countries.

For the first time in history the prospect is that there will be enough food produced to feed, and feed well, all mankind—despite the fact that the population will grow in the next 31 years as much as it has in the last 1,000,000 years. Predictions for the remaining three decades of this century, based upon a two-year study of U.S. agriculture just completed, include:

■ Wheat harvests will jump to 300 bushels per acre, more than ten times present yields.

■ Corn output will reach 500 bushels

CONTINUED ON PAGE 8

INDIA MOVES

Photo © Henri Cartier-Bresson, Paris

Market scene in the city of Ahmedabad in western India, to the north of Bombay.

TOWARDS SELF-SUFFICIENCY IN FOOD

INDIA is in the midst of a dramatic revolution: using new, high-yield food grains, chemical fertilizers, progressive mechanization and modern irrigation techniques, this nation of 540 million people —long cited as proof of the inevitability that the world's population must increase faster than its ability to feed it—expects to be self sufficient in food production by 1970-1971.

This extraordinary leap forward, has been made possible by the successful development of high-yielding strains of rice, wheat, jowar, bajra, maize, groundnut, linseed, rapeseed, mustard, lucerne, etc. This means that the Indian farmer is now able to increase production not by 15 to 20 per cent but by 70 to 80 per cent or more.

Working to bring 32.5 million acres (one-eleventh of India's cultivated area) under the new seed varieties by 1971, he has so far had remarkable success. After the disastrous 1965-67 drought, 20 million acres were planted with a sturdy, prolific wheat, perfected in Mexico. The result was a bumper crop in 1968 of 16.6 million tons, exceeding the previous record by 35 per cent (4.3 million tons). Thirty-eight million tons of rice were grown in the same period, as well as a record maize crop of 6.3 million tons.

ONCE arid and underproductive lands are now blossoming under the benign influence of the "green revolution" as growers and government work together to consolidate their achievements. Several states have launched ambitious programmes to increase handling capacity, storage, transportation and distribution of the bigger crops. Punjab's crash road construction programme is bringing every village to within two miles of an all weather road.

Spurred on by nationwide promotional measures including rebates, transport subsidies and credit, the fertilizer gap is being closed with increased home production that will reach almost two million tons by 1971 and over five million tons by 1973-1974.

Where one kilogramme of nitrogen used to produce 10 additional kilogrammes of grain, the same amount now produces 20-25 kilogrammes of the high-yield crops; the same quantity of water by means of new technology produces at least 2-3 times more food. Through scientific management of soil and water, agronomists and farmers have come up with results that a few years ago would have been considered almost impossible. On land whose production capacity was 3-4 tons of grain per hectare, 10-12 tons are now considered a minimum goal, with 15-20 tons an immediate possibility.

Among the most important grains are new dwarf varieties of rice and wheat. India's first high-yield rice came from Taiwan, followed by a new strain developed by the Philippine International Rice Institute. The dwarf wheat was developed by the Rockefeller Foundation in Mexico, and made available to India by the Ford Foundation. Standing only 18 inches high on a sturdy stock, the new wheat can bear more grain without falling over (see article page 4).

Another decisive factor in India's agricultural renaissance is its increasing independence from the vagaries of the monsoon and ancient irrigation devices. Modern irrigation systems and efficient electrical and diesel pumps have taken over in many areas from bullock-powered water wheels and work will begin next month to extend the area under modern irrigation by 35 million acres.

Well into the planning stage are projects to harness nuclear energy for tapping underground water, manufacturing fertilizers and operating agro-industrial complexes, and current research points to nuclear energy for desalting sea water for use in agriculture.

Priority has been given to the manufacture of modern agricultural machinery, which until now has been mostly imported. Both the power tiller and tractor industries are exempt from licensing provisions, and tractor production reached almost 12 thousand units in 1967-1968, compared to only 880 units in 1961-1962. The target for this year is 18 thousand Indian manufactured tractors.

India's problem is no longer that of getting agriculture moving; it is to keep it going. With the population growing by 13 million each year, production must be increased to 150 million tons to meet the needs of between 630 and 650 million people in the latter half of the 1970s. Indians are confident it can be done. J.S. Kanwar, deputy director-general of the Indian Council of Agricultural Research, writing in the Indian journal, Seminar (August 1968), stated "...A country with 80-90 million acres of irrigated area should be able to produce without difficulty, even with the present technology in agriculture, about 300 million tons of food per annum".

THE industrious and tenacious Indian farmer, no longer condemned to subsistence living, is the key to continued success. His determination to build upon the present "green revolution" is being matched by pragmatic educational programmes to equip him to deal with management and market problems, and to use his resources rationally.

The educational and research challenge is being met by eight new agricultural universities. Quickly responding to the need, the Punjab University—the state's sole agent for agricultural research—has already established a successful range of programmes in co-operation with local farmers, while the agricultural universities of Mysore and Pantnagar have developed far-sighted research and education policies tailored to the needs of their respective areas.

Agriculture's new success appears to have checked the migration of workers to cities and towns, and the more successful farmers can now earn over $1,300 a year, twice as much as a clerk. Land prices have risen, medical services in rural areas have improved and, armed with superior raw materials and benefitting from advanced technology, the Indian farmer is becoming a dynamic contributor to national well-being.

India has made impressive progress in a short time; serious problems must still be overcome, but the agricultural pattern which has been set is a solid foundation for future prosperity.

1,000 calves from a single cow on computerized farms

per acre, against today's average 75 bushels.

■ A single cow will produce as many as 1,000 calves in its lifetime, as compared to the present 10, through the use of hormones which keep the entire cycle of ovulation and pregnancy in cows and other domestic animals under exact control. Embryos will be transferred from special breeder animals to ordinary "incubator" animals with substantial increases in prolificacy of a herd and a radical improvement in quality animal production.

■ Milk production will soar to 30,000 pounds per cow from today's 8,000. Synthetic milk will also be manufactured from carrot tops and pea pods.

■ Today's farm labourers will be increasingly replaced by "farm engineers," scientists and technicians trained in fields ranging from electronics to air conditioning.

■ Farming will become automated and computerized, with tilling of the soil, planting and harvesting crops and regulating the growing process controlled from a centre equipped with computers, radar and remote control devices.

■ Fields will be covered by huge plastic domes, or by other means enabling the constant control of environment affecting crop growth.

■ Remote-controlled harvesters will not only pick but also grade, package, freeze and deliver food to wholesale depots.

■ Space satellites will collect up-to-the-minute data on soil conditions, insect damage, crop growth patterns throughout the world, as well as make long range weather and production forecasts.

BUT this is just a beginning. In the United States alone there are presently some 30,000 research projects under way, and spending for agricultural research is more than $850 million annually.

While today 7,000,000 Americans live on farms producing many times the volume of food 31,000,000 farmers produced a century ago, by the year 2,000 a scant 2,000,000 of the 300,000,000 people in the U.S. will be "farmers." The average U.S. farmer now produces enough food to feed 40 people, four times the number he could feed 30 years ago; in the next 30 years, productivity will increase another four-fold based upon technology already known and within reach.

But in agriculture, as in other fields that are increasingly science—and technology—based, half of what is known today will be obsolete by 1980. Or, to put it another way, at the present rate of technological advance, half of the agricultural technology of 1980 has not yet been discovered.

One of the most immediate effects of the coming agricultural revolution, both in the advanced and in the developing countries, will be an increase in capital intensive farming. Post World War II increases in mechanization in the advanced countries have already far surpassed the "tractor stage":

■ airplanes are increasingly used to spray test-tube "miracles" over crops and pasture lands;

■ computers determine when and how to breed calves by artificial insemination;

■ devices such as the "autosow," which acts as a kind of mechanical mother for baby pigs, are turning pig farming into a mass production industry much like the poultry business;

■ the "Bacon Bin," a recently devised total confinement production facility—complete with automatic feeding and manure disposal systems—can raise and fatten 1,000 hogs at once, from birth to maturity, in record time.

Major international food companies continue to expand their large-scale farming activities, primarily in developing countries. But since foreign-owned "plantations" smack of "colonialism," and for a host of other impedimenta common to the newly independent countries, there have been limited opportunities for private business to contribute directly to the development of badly needed food industries through this kind of direct investment.

With the change of attitudes in the developing countries toward the development of the agricultural sector, the day may not be far off when direct foreign investments in agricultural enterprises may again be welcomed, but for the moment the opportunities for investment in the developing countries lie in other equally interesting sectors vital to increasing food production.

Someone must supply the new varieties of wheat, rice, corn, millet and sorghum in massive and continuing quantities at relatively low prices. And the new "miracle" seed varieties are not enough by themselves to insure the fruition of a green revolution in the developing countries. Suitable quantities of fertilizers, insecticides, water and farm machinery are necessary. Credit, marketing, and other services of modern agricultural systems must be made available.

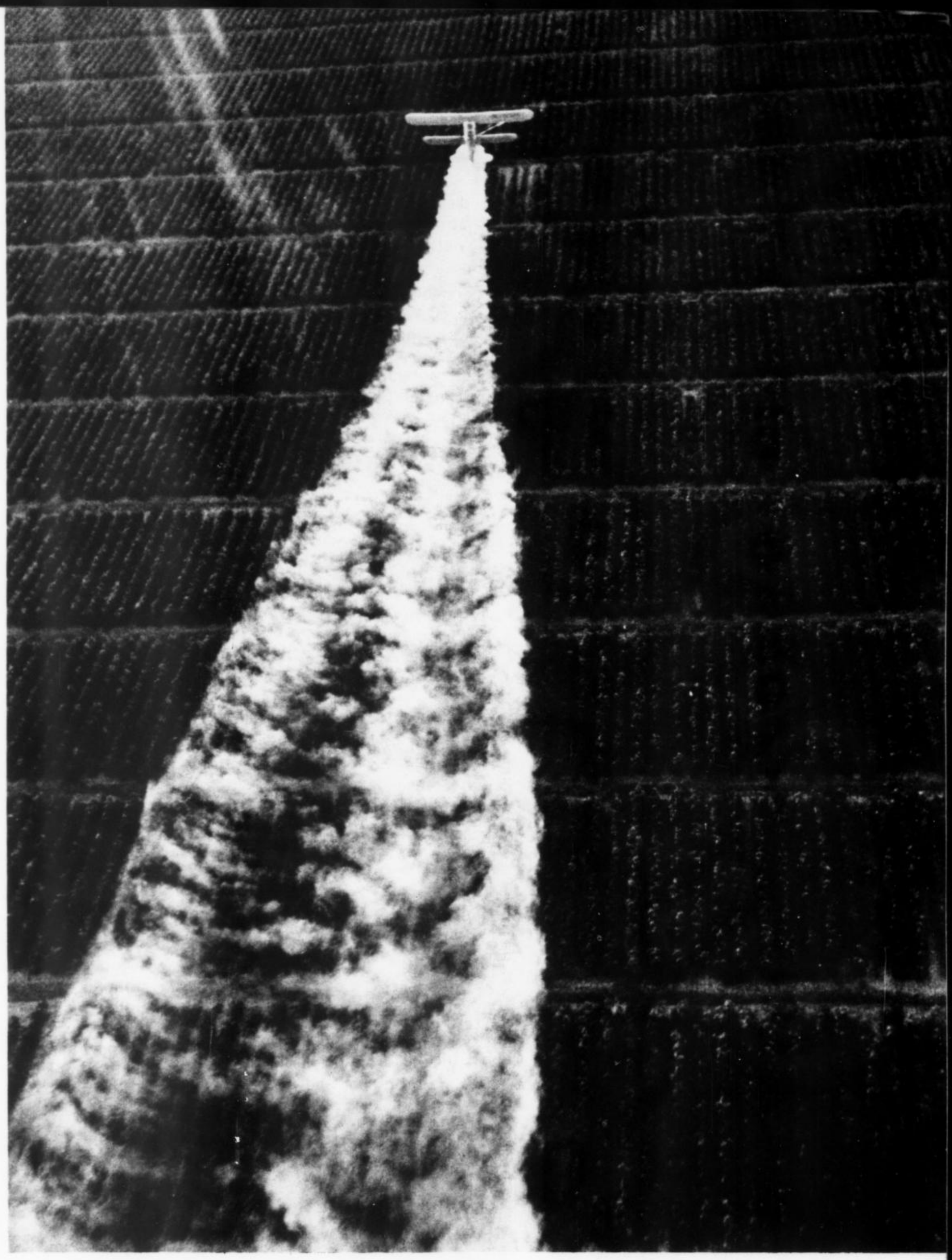
The way the new seed varieties were introduced into the Philippines, India and Pakistan had as much to do with their success as does the quality of the seeds themselves. Rice "kits" consisting of the seed, fertilizer, insecticides needed to grow a half-acre of one of the seed varieties were sold or distributed together. This novel distribution concept presents a special challenge to abilities of international corporate enterprises to develop the required joint marketing facilities.

THE governments of developing nations, local private business and the farmers cannot sustain this effort without outside help. They lack the means to do the adaptive research, the facilities needed to train farmers in modern agricultural techniques, the public finances for large-scale irrigation and rural electrification projects, or for adequate storage and modern transport facilities. They often lack the required technology, capital and managerial personnel necessary to build new plants to produce the required seed, fertilizer, insecticide and other essential inputs.

To meet these needs, governments of OECD countries have appreciably increased their aid to agricultural programmes of developing countries in recent years. The World Bank announced in October 1968 that it would quadruple loans to speed the development of world agriculture. The Inter-American Development Bank now commits about 27 per cent of its funds for agricultural development purposes, and the Asian Development Bank—formed just two years ago—is presently engaged in a country-by-country survey to assess priority projects to be considered for assistance by its projected Agricultural Development Fund.

But producing food is business. And many of the resources needed by developing countries to get the nascent agricultural revolution off the ground are the almost exclusive possessions of private enterprise in western industrial countries.

To mobilize the resources of private



FLYING FARMER
In today's large-scale farming operations an airplane is often the best tool for spreading pesticides.

Photo © Life

industry for food production in developing countries, the FAO has created the FAO/Industry Co-operative Programme, a joint effort by the FAO and international business to resolve problems involved in the establishment of industries in the developing countries to manufacture fertilizers, pesticides and farm implements or to process food and other agricultural products. At its March 1968 meeting, representatives of 37 major international firms met at FAO headquarters in Rome to work out a widely acceptable code of conduct for the protection of private foreign investors in developing countries.

The most tangible sign of the effectiveness of this programme has been in India's crucial fertilizer industry. Until the drought of 1965-66, administrative and political problems had prevented an effective involvement of international private business in major new ventures in India. After the creation of the programme, the FAO actively assisted the search for ways to eliminate obstacles to new investments in critical food or food-related industries.

As the urgency of increased agricultural production grew, the climate for investment in India in these industries began to change for the better. With the 50 per cent jump in fertilizer consumption in 1967 having contributed substantially to the rapid recovery from near-famine conditions, top priority has been given to the development of 15 major fertilizer factories.

But fertilizer production is just one field of immediate opportunity for inter-

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High-protein foods: Pride and Prejudice

national business. Almost all developing countries have undertaken more or less extensive agricultural training programmes, which hold the key to the introduction of new farming techniques including the mechanization of farm production. The South American Farm Mechanization Training Centre at Buga, Colombia, illustrates how such programmes can be effectively developed through co-operation among industry, the FAO and governments.

With FAO's guidance through the Freedom from Hunger Campaign, the Colombian National Training Service and a British farm machinery manufacturer set up the centre to train technicians from Colombia and other Latin American countries as instructors in farm machinery operation and repair and as government extension officers.

With wide experience in such training programmes in the United Kingdom, France, the Federal Republic of Germany and each of the Scandinavian countries, the British firm was in a position to provide the necessary instructional staff, as well as a broad range of tractors, equipment for workshops and teaching aid. The company's donation to this project, which will eventually amount to approximately $300,000, represents a far-sighted investment in South American agriculture development.

ANOTHER field of potential industry-government co-operation involves one of the most widely discussed developments in the world food industry, a process developed by a British petroleum company at its French refinery for producing protein from crude oil. The final product, a yellowish, odourless powder, is comparable to fishmeal in composition. But, like fishmeal, it is not yet suitable for direct human consumption. It is, however, suitable for feeding to animals and poultry, which in turn convert it to the traditional and still most acceptable food forms—meat, milk and eggs. (See article page 21).

While some experts say that it will be at least ten years before we will see human food derived directly from protein produced from petroleum or from natural gas, several oil and chemical companies consider the potential demand for the product great enough to begin their own development programmes. India has already started producing proteins from petroleum hydrocarbons with pilot plants under the direction of the Indian Institute of Petroleum at Dehradun and the Regional Research Laboratory at Jorhat.

A number of high protein concentrates have also been developed from various vegetable and fish sources. Dr. Norman W. Pirie, head of the biochemistry department at Rothamsted Experimental Station in England, has developed one of the most recent—a process for extracting protein from green leaves, such as pea cannery waste.

A Swedish company is now producing a fish protein concentrate which, mixed with water and cocoa powder, has been used recently in Nigeria and Biafra.

At the American University of Beirut, a new supplementary—called Aubina—has been developed from wheat, Egyptian chick-pea, bone-ash and skim milk, and tests have shown that children find it good to eat.

Both soya and cotton-seed have long been sources of protein concentrate. But while the day may not be far off when meat, bread and even bacon made from these materials will be part of man's normal diet, so far protein-rich foods have received an extremely cool reception.

While there is a certain compelling logic in the argument that protein concentrates are "good for you," there still remains the problem of how the stuff tastes. And experience shows that unless people are really at the starvation level, they are particular about the taste of the food they eat.

This was the sum and substance of a number of scientific papers presented to the combined FAO/WHO/UNICEF Protein Advisory Board last September. According to Dr. O. Ballarin, an executive of the Brazilian subsidiary of a Swiss food company, all efforts by private enterprise in South America to sell and promote high-protein produce have met with disappointing results, and in some cases failed completely. In Peru, production of a high-protein fish flour produced from anchoveta was discontinued after sales sank to a disastrous low. Similar difficulties have been met with in Africa.

Specialists give these reasons for consumer resistance to something that is obviously "good for them":

- Traditions regarding food are stronger in developing countries than in developed ones. New foods, delivered in a new form or a new package, are looked upon with suspicion.
- Most people ignore the meaning of the word "protein," which has no commercial appeal.
- People shun high-protein products for social reasons, regarding them as "the food of the poor."

IN Ethiopia, some of these obstacles were overcome by the nutritionists, who called their product Faffa (meaning "grow big and strong" in the local language). Faffa was a success. But in many other countries, where illiteracy ranges up to 85 per cent, and people cannot even read the name of the product, promotion campaigns have to be carried out through films, radio and television.

Nevertheless, specialists such as Dr Husain Ali Bhimjee Parpia, Director of the Central Food Technological Research Institute in Mysore, India, are firmly convinced that protein malnutrition can be overcome in much of the developing world if the available resources of oil-seed protein are utilized more efficiently. As soon as acceptable products can be perfected and attractively presented through regular commercial channels, vegetable protein sources will certainly make a major contribution to solving present nutritional problems.

Weaning foods, biscuits, ice cream, beverages and candies are the preparations which are now under consideration by major international food processors. Three American companies are now apparently convinced they are on the brink of a major breakthrough in this field. One is planning to manufacture and sell throughout Asia a highly popular Hong Kong soybean drink with a satisfactory amino acid content. A major soft drinks bottling firm has developed a chocolate-flavoured, soybean-based high-protein beverage, fortified with vitamins; this potent concoction has already been launched on the Brazilian market. In El Salvador, a third company has just completed consumer testing on a new high-protein soft drink made from corn meal, cottonseed and nut meal.

But if the development of synthetic nutrients provides the basis for an entire new sector of the food industry, prospects for expansion in the exploitation of the world's marine resources is undoubtedly more immediate. The sea is, for the foreseeable future, an almost limitless source of high-protein content food. Annual production of plants within the oceans, according to

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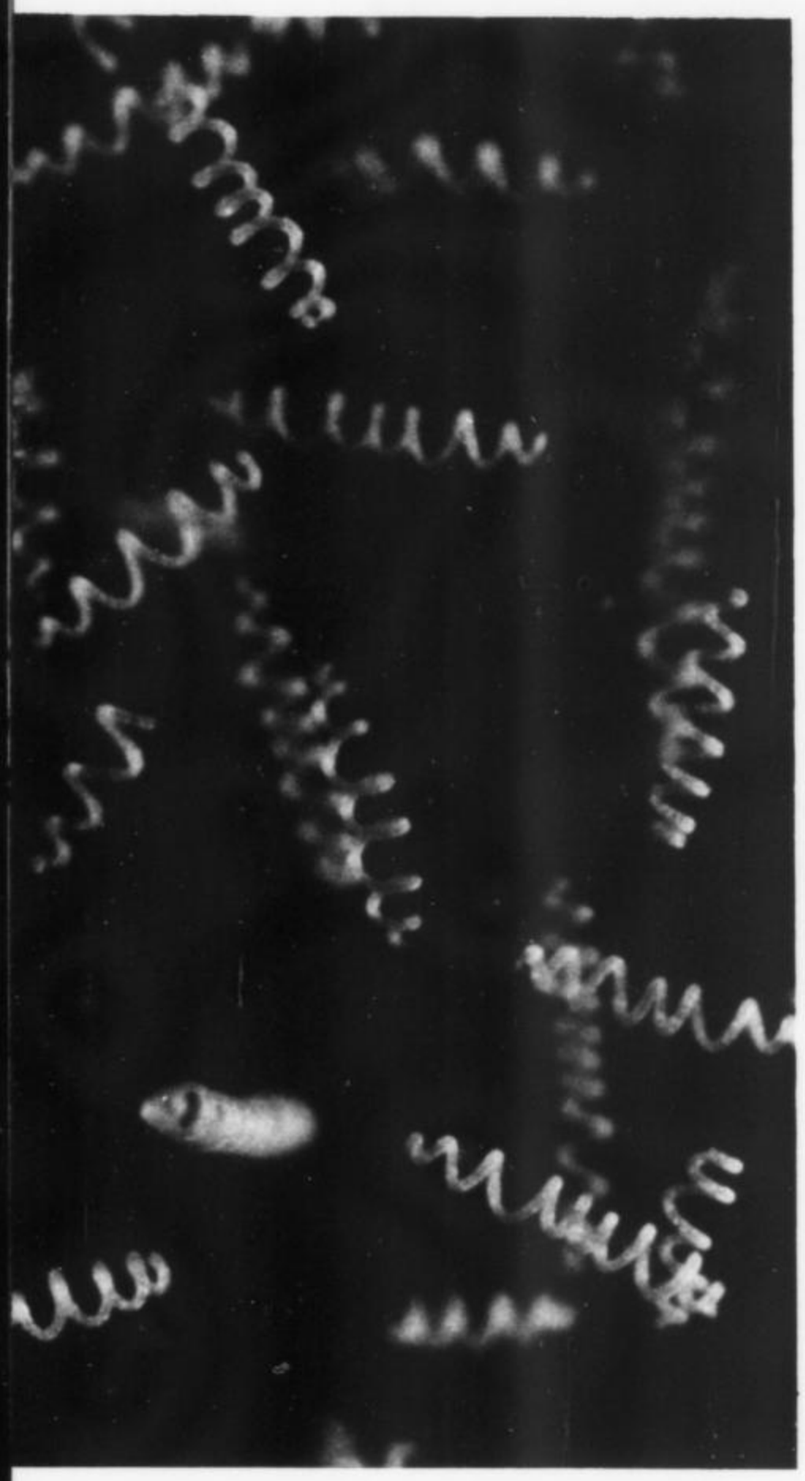

ALGAE, THREE TIMES AS NOURISHING AS STEAK

Photo © Max-Yves Brandily

Photos Institut Français du Pétrole

Several years ago, certain communities in the Republic of Chad were found to be eating a blue alga called Spirulina (above left), which grows in ponds rich in mineral salts, and highly alkaline. After it is harvested, women form it into pancakes to dry in the sun (above), before taking it to market. The ancient Aztecs consumed a similar alga which grew in Mexico's lakes. Spirulina contains between 60 and 68 per cent protein, that is, six times as much as in wheat and three times as much as in beef. French and Mexican research laboratories, excited by its large-scale nutritional possibilities, are experimenting with its artificial cultivation. The culture is produced by photosynthesis in vats of lukewarm salt water (left), which are fed with carbonic gas. Results show that the annual yield of Spirulina could be 40-45 tons per hectare with a 25 ton protein content, as compared to only 30-40 kilogrammes of beef protein per hectare.

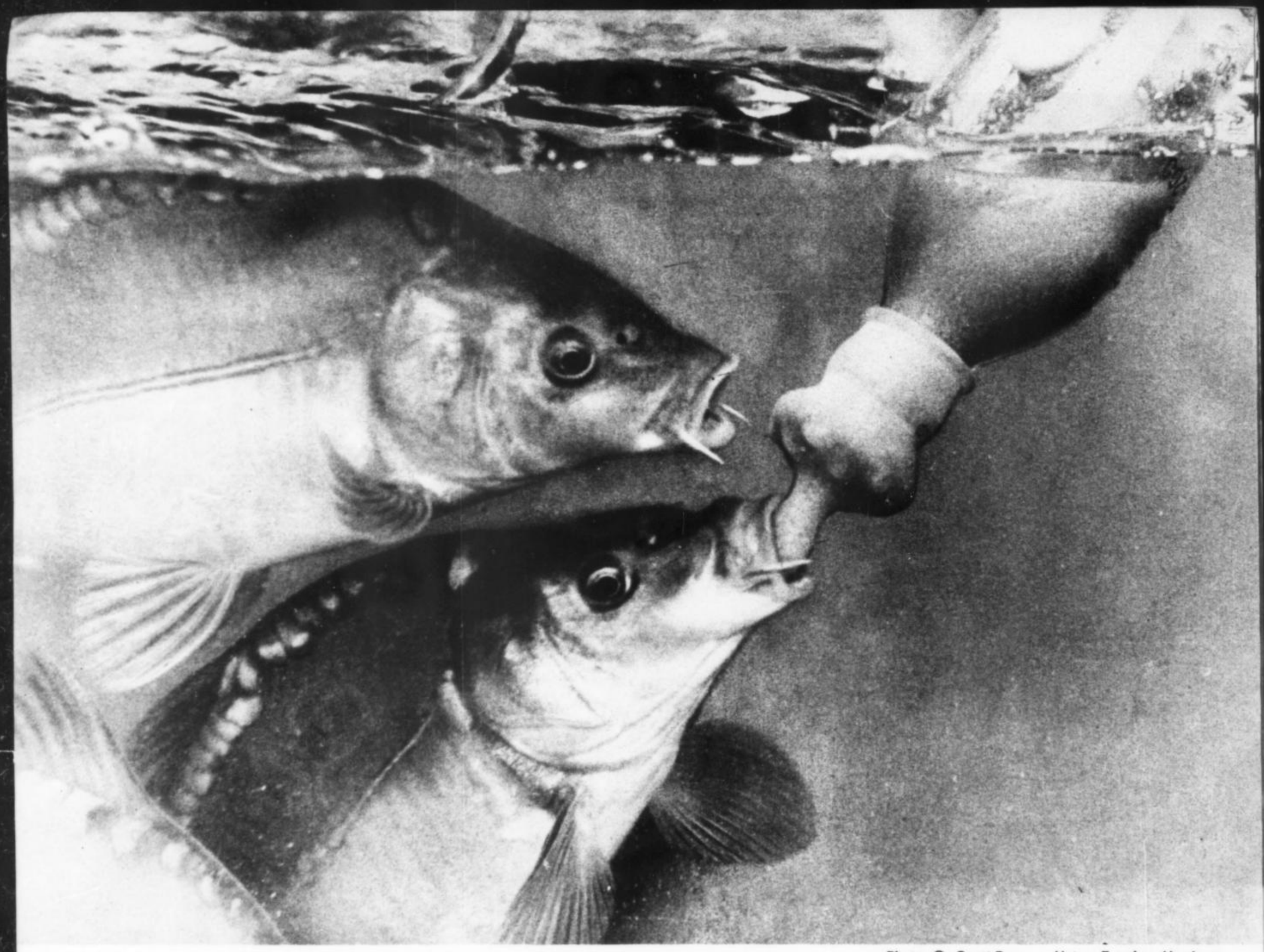

Photo © Conti-Press - Heinz Fremke, Hamburg

BOTTLE-FED CARP. Carp queue up for their baby bottle of fish meal, crushed soya bean and vitamins. On this diet provided at the Max Planck Horticultural Institute in Hamburg, Germany (Fed. Rep.) the fish grow to 14 pounds (instead of 3) in three years. Rose flower, opposite, is extraordinary pattern, formed by sea slug eggs on sea floor.

THE NEW FOOD REVOLUTION *(Continued)*

the FAO's Fish Stock Evaluation Branch Chief, John Allan Gulland, is approximately 130 thousand million tons—hardly any of which is used for human consumption. And of the 23 thousand million tons of fish and shellfish the ocean grows per year, the present world-wide catch is about 60 million tons.

While much of the plant life—the phytoplankton—is generally microscopic and neither easy to harvest nor attractive to use, there are vast possibilities for expanding the fishing industry. At present the world catch of fish, rising annually by from 6 to 8 per cent is growing faster than the world's population. World fisheries production increased from 19 million metric tons in 1948 to 60 million tons in 1967, or at a rate much faster than food production from the land.

But present fishing methods are still traditional and primitive. Production might well be doubled in the next ten years through the use of new electronic equipment which detects the presence of schools of fish, speeds the movement of nets, and even lures fish into the nets.

While most of the world's fishing grounds are being quite intensively worked, the Indian Ocean—one of the world's least known oceans—may well be one of the richest and most underdeveloped. Recent estimates submitted to the FAO's Indian Ocean Fishery Commission indicate that the yearly catch of fish in the Indian Ocean could be increased about ten times, from its present level of 2 million to 20 million metric tons annually—without damaging the stocks. In the more immediate future, current production could be raised to 10 million tons a year, putting the ocean's fisheries on a par with those of the North Atlantic, which yield approximately 11 million tons a year.

Still, if fishing remains confined to the types of fish now exploited, experts estimate that the world catch would probably approach its physical limit within the useful working life of fishing vessels now being built. Alternative sources of natural production include both fish and other animals more or less unfamiliar to most fish consumers.

For instance, squid of various types appear to be abundant in many parts of the world, but exploiting the very large quantities of this creature—now eaten readily only in Japan and Mediterranean countries—depends as much on changing the tastes of the consumer as on being able to catch the animals economically.

Several developments over the past

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NURSERIES OF THE SEA

by Wesley Marx

OYSTERS on a half shell, steaming clams, broiled salmon steaks, shrimp cocktail—all these cherished seafoods and many more may dwindle unless we stop ourselves from destroying their very birthright.

A common misconception contributes to the rise of such a tragic spectre. While the ocean regime may appear to stop at the shore, its vital processes extend into our bays, salt marshes, rivers and even our mountain streams.

In a magnificent migration, silver-toned salmon rise from cold ocean depths, navigate to river mouths in Europe, Scandinavia, Asia and the Americas, swim intently against river currents, hurdle small waterfalls and finally pause in green-shaded mountain streams far from the blue ocean. Here they were born and here they will give birth, their tail fins scratching out cribs in the gravel bottom. Many other marine fish use rivers as nurseries: shad, striped bass, alewife and the ugly, caviar-bearing sturgeon. These river-ascending fish are called anadromous—"upward-running".

An even greater spectrum of marine life is nursed and reared in estuaries, those places where the oceans and rivers of the world collide to form bays, salt marshes and fjords. Here, succoured on rich nutrients and sheltered from sharks and other marine predators, young tarpon, snook, mullet, menhaden, dab, plaice, flounder and smelt prepare themselves to enter the vast ocean.

Estuaries nurse West Africa's principal catch, the bonga, and India's favourite fishes, the hilsa, bombay duck, cock-up and pearl spot. Shellfish—clams, oysters, scallops, mussels—and crustacea—shrimps, lobsters, crabs—flourish in estuaries. In the United States, two-thirds of the marine catch is estuary-dependent. Many fish which keep to the sea are, in turn, dependent on estuaries for providing forage fare. Our rivers and our estuaries are thus vital nurseries of marine life, the repository of the birthright of so many fish and shellfish.

Much of the world's population lives on or near coast-lines and we tend to see estuaries and rivers in man-made roles: harbours, navigation channels, land reclamation projects, sewage ponds, sand and gravel pits. This narrow vision triggers a tragic collision between human geography and natural geography, as exemplified by one beautiful, world renowned bay. San Francisco Bay makes the city of San Francisco one of the most charming urban regions in the world, part peninsula and part ocean bay, part green mountains and part blue plains. Here the United Nations was created. The bay traditionally serves as a vast mar-

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WESLEY MARX *has written widely on the impact of technology on the environment, particularly the ocean. He has participated in several scientific expeditions and made extensive field trips on both the Atlantic and Pacific coasts of the U.S.A. to gather material for this article. His book on ocean conservation "The Frail Ocean" (Coward-McCann, New York) was published in 1967.*

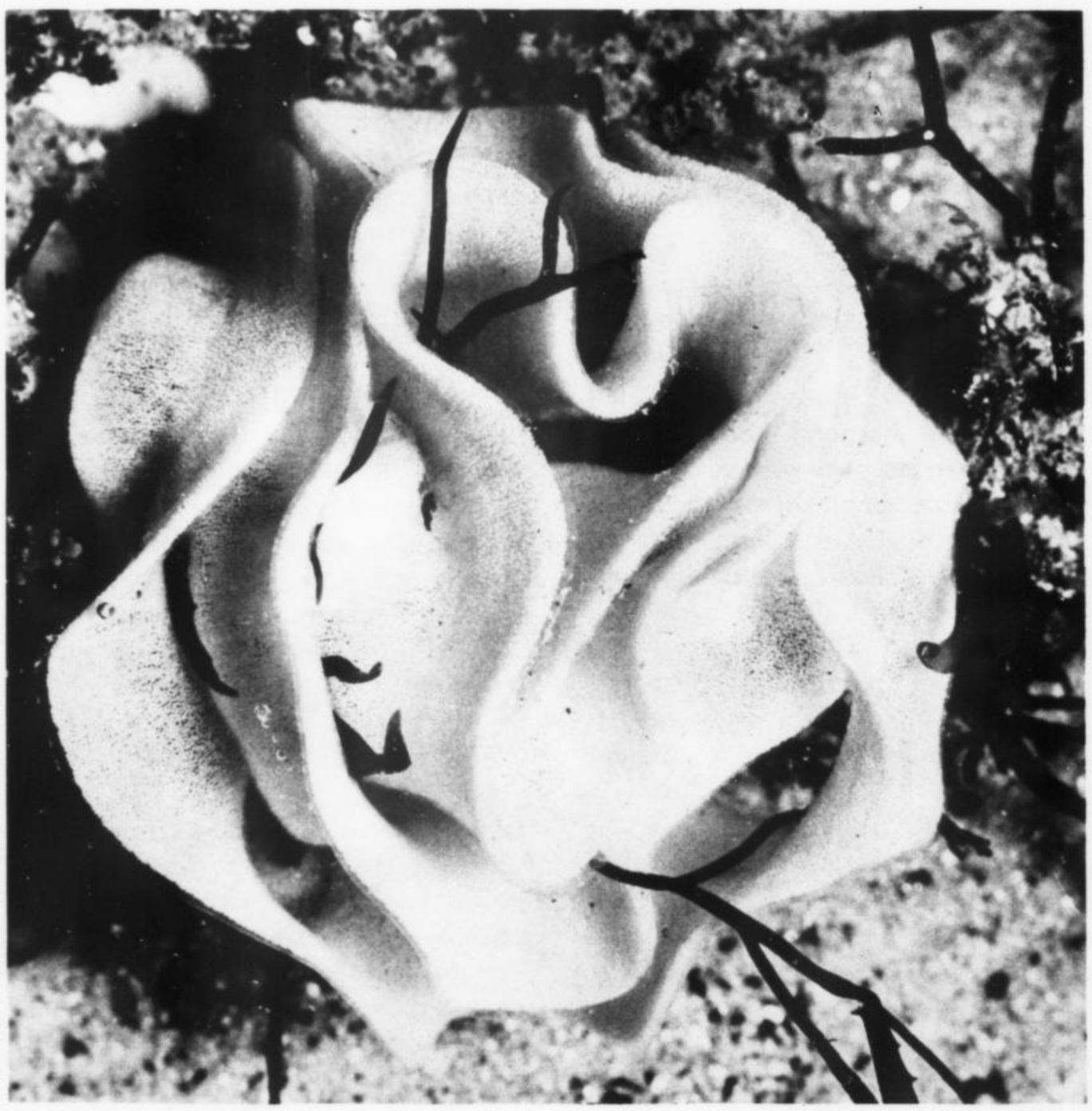

Photo © Jacana - Philippe Summ, Paris

Let's not kill the fish that lay the golden eggs

ine nursery and a passageway for salmon and other anadromous fish.

At one time, the Pacific coast's largest commercial fishing fleet docked in the bay. Yet today no commercial fishermen trawl their seine nets in its sunlit shallows. The marine nursery is a ghost nursery. It exists largely as a giant cesspool, a garbage dump and a real estate reservoir.

As a cesspool, it receives the discharges of over 80 sewage outfalls. Daily, some 60 tons of greases and oils cascade into the bay and paralyze the nerves of striped bass. Acid wastes burn salmon gills and disrupt breathing. Papermill effluents disrupt the normal division of eggs and fishermen catch freakish flounder. These wastes have transformed the life-giving bay waters into a toxic broth.

Ninety per cent of the bay is closed to shellfish harvest. Keeping it clear as a navigation channel means that fish habitat is dredged up and oyster beds interred under silt avalanches. As a garbarge dump, marshes that once nurtured eelgrass and other nutrients now exude only hot, pungent odours of decay. Tideland habitat has been buried to accommodate apartments, shopping centres, airport runways and athletic stadiums. A third of the bay—some 257 square miles—has been reclaimed.

THE bay that once provided 15 million pounds of oysters annually no longer supports oyster production. The bay that once provided 300,000 pounds of clams annually no longer supports clam production. The bay that once provided six and one-half million pounds of shrimp annually now produces only 10,000 pounds.

Such a tragic waste is repeated in other famous estuary and river systems throughout the world. Dr. Pieter Korringa, Director of the Netherlands Institute for Fisheries Investigation notes:

"The river Rhine, in season, used to teem with salmon making their way to their spawning grounds in Germany, France and Switzerland. Old paintings in art galleries reveal that salmon was on the table of the poorest people in the Netherlands. In the Netherlands today, few people have even seen a salmon which did not come out of a tin, or was on display, smoked, in a fishmonger's shop. The Rhine is now called Europe's open sewer."

In the 1900s, fishermen on England's River Tees harvested 8,000 pounds of salmon yearly: by the 1920s, 3,000 pounds; now, virtually zero. A new and deadly tributary empties into the Tees: twelve million gallons of sewage daily. Sewage-nourished "blooms" of scum algae render some of Norway's deep blue fjords opaque. These dense greenish blooms, by exhausting oxygen in the waters, suffocate marine life and leave stinking windrows of dead fish on the beach.

LIKE sewage outfalls, river dams can seriously impair the nurseries of the sea. Soviet marine biologist G.V. Nikolsky notes in his book "Special Ichthyology":

"The fishing industry and ichthyology in general are faced with new, vast problems through the construction of huge hydroelectric plants. Dams built across the southern rivers of the U.S.S.R. are liable to obstruct and prevent valuable anadromous commercial fish, primarily the sturgeon, from reaching their spawning grounds."

The dams, by directing river water into irrigation diversions, also serve to lower the level of seas such as the Caspian, further shrinking the habitat of the famed sturgeon. Sewage outfalls threaten sturgeon as well. Soviet author Mikhail Sholokhov recently reported that almost a million sturgeon died on one polluted stretch of river. Today, in a critical effort to sustain its long-established caviar industry, the Soviet Union loads sturgeon aboard river boats to carry them safely through slime that covers their migration routes.

Unprotected, the nurseries of the sea can degenerate into nurseries of death that threaten human beings as well as fish. Eleven fishing villages and the industrial city of Minamata line the shores of Minamata Bay in Japan. In 1950, a nerve disease began affecting some residents. A once bright teenage boy could no longer button his clothes or hold his chopsticks. A fisherman clawed his hands, bared his teeth at doctors and growled at his children. Between 1953 and 1963, some 105 similar cases occurred, most ending fatally or with severe disability.

Perplexed by "Minamata Disease," doctors tried to isolate living habits common to victims. Most victims lived in the fishing villages rather than the city, and these victims subsisted on the bay's abundant supply of shellfish. While healthy in their own right, the bay shellfish were found to contain unusually high concentrations of mercury, a substance highly injurious to human nerves.

Where did the mercury come from? Investigators, including Professor Makio Uchida of Japan and Dr. Leonard Kurland of the United States, found that a chemical plant was dumping mercury wastes into the bay. The wastes were diluted, but shellfish can filter out and concentrate dilute substances. "Ecological magnification," a basis of survival in the dilute solution of sea water, had thus been perverted and the shellfish turned into living vials of poison. "Minamata Disease," according to Professor Uchida, ceased once the chemical plant stopped dumping mercury wastes into the bay and consumption of bay shellfish was prohibited.

RECENTLY New York City experienced a sharp rise in cases of hepatitis (inflammation of the liver). Many victims remembered consuming oysters. The source of the oysters was traced to a nearby bay. Oysters in this bay were found to have an oily taste. The oyster meat was greenish rather than white. Oil wastes in the bay contributed to the oily seasoning. Copper wastes contributed to the greenish hue. These oysters, marinated and steeped in wastes, were inflaming the livers of New Yorkers. Today the bay oysters lie in quarantine just like the shellfish of Minamata Bay.

The tragic degradation of the Rhine, Minamata Bay and San Francisco Bay dramatizes one stark fact. If we continue to ignore the ocean's need for

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On a beach in Bali. Photo © Marianne Spier-Donati

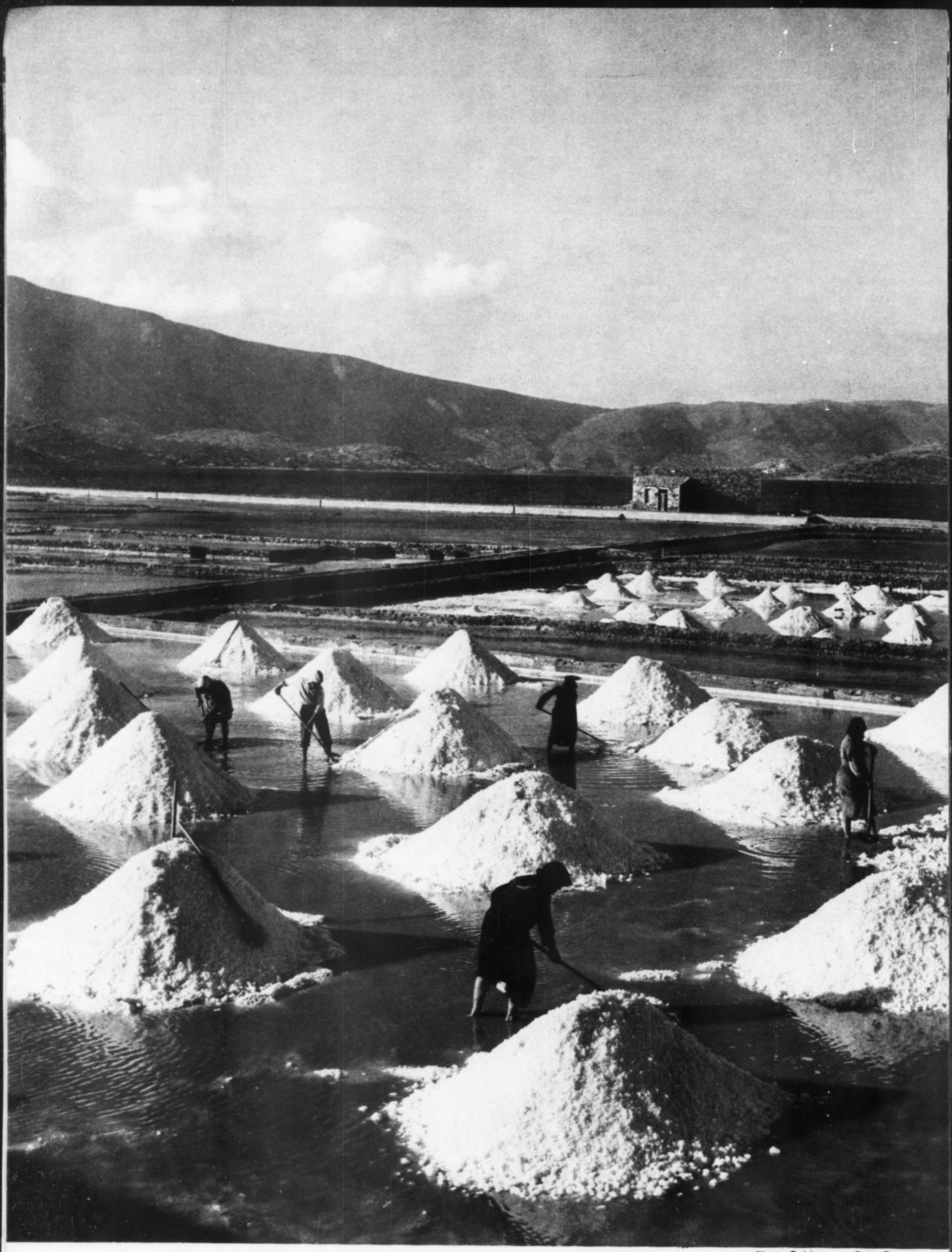

Photo © Marianne Spier-Donati

Gleaming piles of salt, harvested from salt-pans on the coast of Crete.

Leading the salmon by the tip of the nose

its landward nurseries, we will gradually doom our most valuable and popular sea foods.

Not only will the livelihood of fishermen, the diet of millions of people and the favourite recipes of gourmets be jeopardized. Nutrition experts see in the food stocks of the ocean the potential to satisfy the hunger of an increasingly congested planet. (See article page 4.) National agencies and international agencies like the Food and Agriculture Organization are attempting to cultivate this potential, but these attempts will be seriously jeopardized if we persist in sterilizing the nurseries of the sea.

Efforts to reverse this trend are intensifying but face great obstacles. The banning of all man-made activities on rivers and estuaries would certainly serve to reverse such a trend. But such a ban would be not only impossible but unnecessary. Estuaries and rivers can act as both nurseries of the sea and as an industrial resource—but only in proper balance. To effect such a balance, the stresses and tolerances of marine life must be known and evaluated.

YET man's study of the land environment has traditionally (and understandably) outstripped his study of the marine environment, and his lag impairs marine conservation. The dangerous plight of salmon and other anadromous fish has been known for some time, but solutions have had to await a better scientific acquaintance with these fish. Only recently have investigators offered a substantial explanation of how spawning salmon find the stream where the were born five or six years earlier. Experiments by Dr. Arthur Hasler at the University of Wisconsin in the United States indicate that salmon locate their parental stream by sniffing out the stream's particular odour.

The application of such knowledge can prove as time-consuming and rigorous as its discovery. Salmon eggs were artificially hatched over 50 years ago. This capability was heralded as the answer to salmon conservation. Yet salmon hatcheries have never been able to match nature's former abundance.

In the final analysis, proper protection of fish habitat determines survival. Accordingly, on many rivers, dams have been fitted with salmon ladders, water quality standards imposed on sewage outfalls, spawning streams cleared of logging debris and mine tailings, and screens placed on irrigation canals that can divert young salmon into fatal dead ends.

BOTH scope and cost of such measures can rise quickly. The Columbia River in the United States has 21 salmon hatcheries, 22 fish ladders and some 600 screened irrigation diversions. Some 1,700 miles of stream bed have been cleared of debris. To better conserve salmon conservation funds as well as salmon, Dr. Hasler is now considering the possibility of diverting spawning salmon from polluted parental streams to clean streams by duplicating stream odours. Clean streams are being created by draining wilderness areas with concrete water channels and coating these channels with gravel suitable for salmon cribs. Through such techniques, salmon and other anadromous fish may be diverted to habitat purposely maintained to perpetuate their abundance.

Maintaining the habitat of estuarine life is proving an even more demanding task. Though seemingly a simple body of water, an estuary is in reality a biological engine driven by currents, tides, wind and other mechanisms that change from day to day. Left to its own devices, this sophisticated engine can sustain a natural productivity that rivals the fertility of jungles and that nurses millions of the ocean's young. If disrupted, it falters as assuredly as an automobile engine fed on salt water.

Circulatory currents serve to trap nutrient matter in an estuary as food for young fish. But these currents cannot discriminate between nutrients and toxic wastes, and research scientists now find that the waste receiving capacity of estuaries is sharply circumscribed by this factor. A sewage outfall that discharges large amounts of fresh water, or a dam that restricts fresh water inflow can alter the critical mixture of fresh and saline water that estuarine inhabitants require. Thus fresh water, or the lack of it, can become a polluting influence.

We will never be able to conserve the nurseries of the sea until we can understand such complex relationships, understand them so well that we can break them down in as much detail as the components of a jet engine. The United States is creating a hydraulic model of the Chesapeake Bay, a body of water nourished by 100 tributaries, the tides of the Atlantic and numerous metropolitan sewage outfalls. The model will be used to predict and balance the impact of sewage, dredging projects and dams on the Chesapeake biota. The aim of this large-scale project is not only to conserve Chesapeake Bay but to advance the knowledge of estuarine conservation in general.

Through extensive research, investigator E. Foyns of Norway has evolved technology to prevent sewage from producing deadly slime in estuaries. Sewage entering the Oslo Fjords is exposed to electrolytic precipitation to remove phosphorous, a slime-forming catalyst.

THE common global interest in conserving the nurseries of the sea and preventing marine pollution, is more and more being recognized. The FAO Advisory Committee on Marine Resources Research (ACMRR) has been questioning governments on the fisheries aspect of marine pollution. Working with ACMRR, the Intergovernmental Oceanographic Commission (IOC) has set up a Working Group on Marine Pollution, headed by Dr. Korringa of the Netherlands. This month, specialists from Unesco, the Food and Agriculture Organization, the Inter-Governmental Maritime Consultative Organization and the World Meteorological Organization meet in London to study problems of marine pollution.

Such efforts are aimed at establishing a general scientific framework for the conduct of research into marine contamination that will serve to avoid duplication and expedite practical control measures. In addition, indus-

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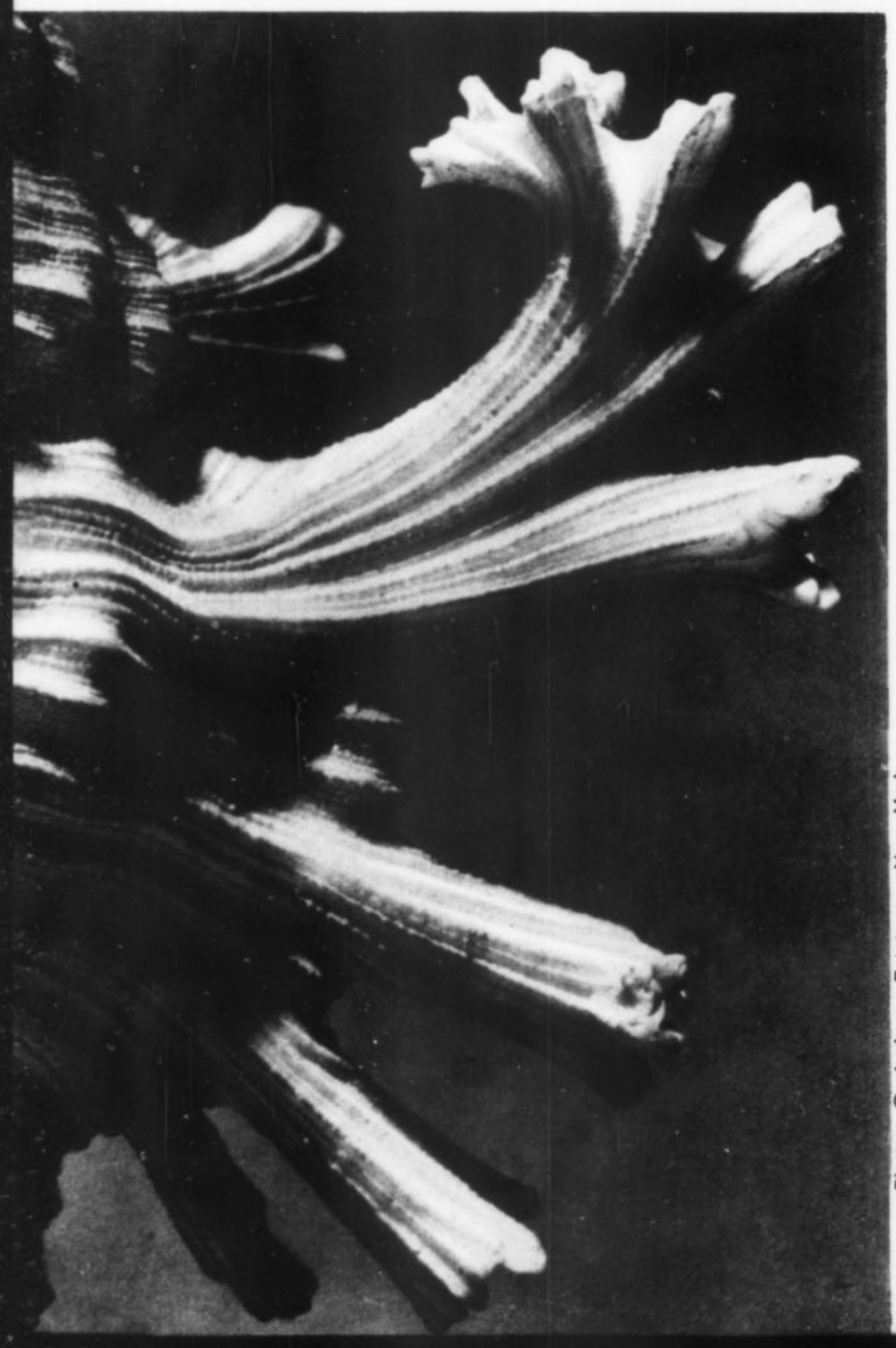
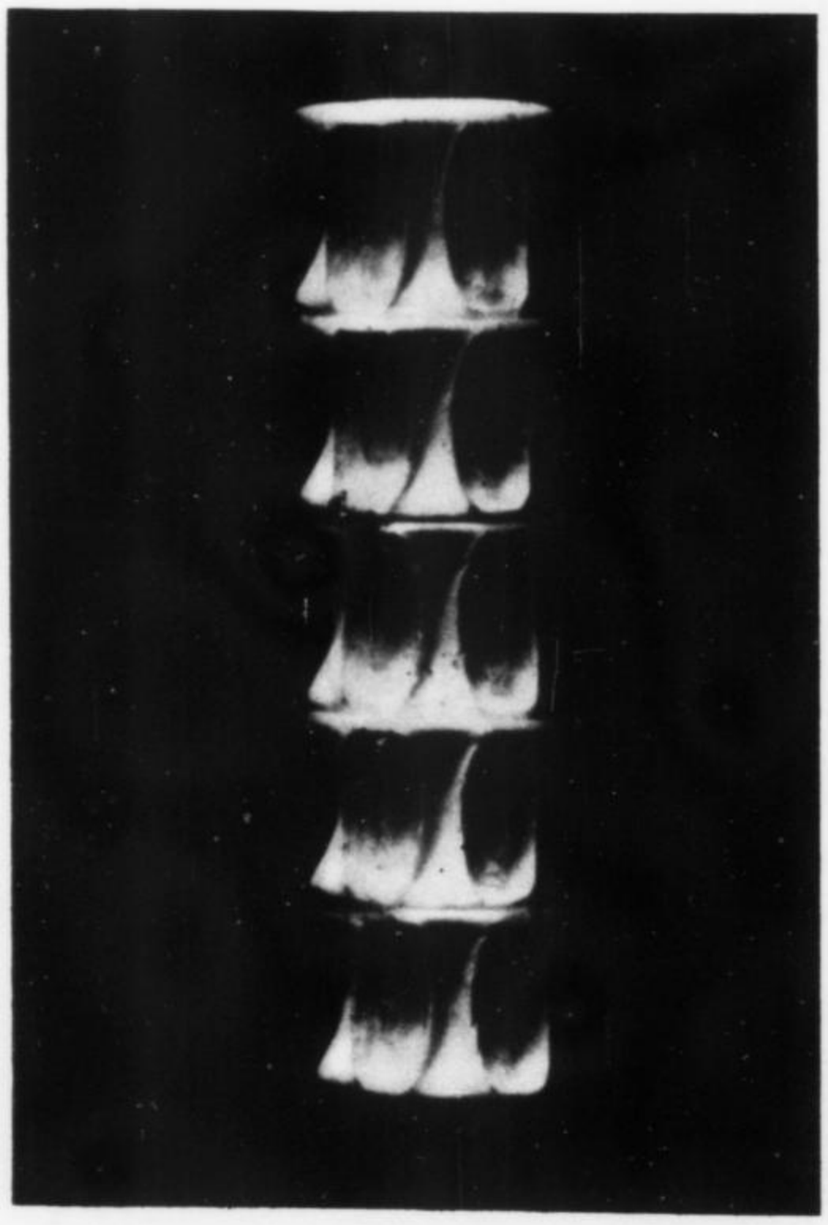
FORMS OF NATURE

"No artist could improve the beauty, no craftsman match the perfection of execution, of these structures that grew in accordance with inherited patterns going back to the beginnings of time." Thus writes Andreas Feininger in "The World Through My Eyes" (Crown Publishers, New York), where the famous American photographer presents some of his favourite pictures taken during the past 30 years. Among these are masterly close-ups from nature, including the shells shown on these pages. "The variety of forms of nature is unlimited, their number infinite", he says. "These photographs show different solutions to the protective needs of certain molluscs. Each shell evolved to provide maximum protection in accordance with the specific environment and way of life of the respective mollusc, the different requirements being reflected in the differences in design: corrugated, ribbed, or spherical surface; presence or absence of protective spines; thinness or thickness of the walls." Opposite, gasteropod; right, murex, from which the Ancients obtained purple dye; below right, part of the spinal column of a skate.

Photos by Andreas Feininger





Photos © Andreas Feininger, New York

Oysters at bay

trial nations which learn how to salvage desecrated nurseries can show developing nations how to avoid such desecration in the first place.

Comprehending the nature of the nurseries of the sea will not alone guarantee their survival. An obstacle as formidable as would be a dam without a fish passage remains. Traditionally, estuaries and rivers have not been administered as complete marine systems but as subdivisions of political systems on land.

Thus, some 90 bayfront communities and a host of private and government agencies have utilized San Francisco Bay with little reference to each other's needs or the health of the bay itself. (The land reclamation project of one community now threatens to cut off a neighbouring community's access to the bay). The equivalent on dry land would be the use of a farmer's wheat fields by his neighbours as a cesspool, a dump, a playground and a highway right-of-way, or their requisition for use as a reservoir.

Effective conservation of the nurseries of the sea will require more comprehensive systems of management. In the case of San Francisco Bay, a pioneer marine commission has been formed. Composed of local, state and federal officials, the commission is empowered to view the bay as a single system and evolve a plan that will balance development with conservation. A major goal of the commission is to restore the bay as a prime marine nursery.

OTHER countries are increasingly realizing the importance of marine nurseries and at the same time, invoking penalities against exploiters who ignore their true values. In Sweden, sponsors of hydroelectric dams must provide compensation for any disruption of salmon runs. In the Soviet Union, fish protection agencies may bring suit against industries or communities which pollute fish habitat by dumping excess wastes into the water. In Japan, fishermen can claim heavily from industrial construction enterprises that usurp or damage marine nurseries.

In many places, protection of marine nurseries requires international action. The Fraser River flows through the Canadian province of British Columbia and empties into Puget Sound, a Pacific coast estuary bordered by the United States and Canada. By banding together in an international commission, these two countries have restored the Fraser's great salmon runs, once blocked by careless riverside construction. An international commission has now been formed to restore the Rhine to its former biological wealth. In time, fresh salmon may once more grace the dinner tables of Western Europe.

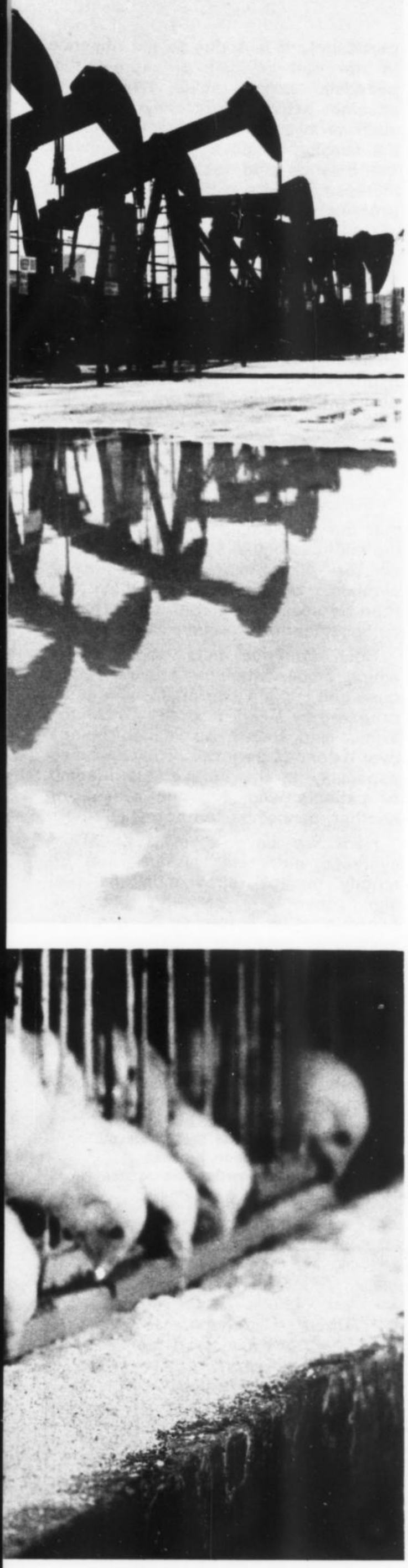
THE growing efforts to save the nurseries of the sea will demand much in the way of research, technology, money and political co-ordination. But these nurseries will reward such attention amply enough. In supporting a new programme to conserve the United States' 106 anadromous rivers, the director of the U.S. Bureau of Commercial Fisheries declared: "In looking at what I consider to be the rather phenomenal success in the Columbia River, I would say that we could certainly justify this on the cost-benefit ratio very well."

Yet there is far greater justification, indeed necessity, for such efforts. We now realize that, if we deny the ocean its nurseries, we deny ourselves a food source regarded as crucial to human survival. We also deny ourselves a grand opportunity. Dr. Lionel Walford, Director of the Sandy Hook Marine Biology Laboratory in the United States observes: "While the estuary is the one part of the sea that man can ruin, it is also the part that he can control in order to increase the production of marine life."

Oyster and mussel cultivation provide only a glimmer of the future benefits to be derived from ranching and farming our estuaries. The nurseries of the sea, with their present bounty and great potential, demand our respect and our care. Leaving a heritage of carp, gar, rat-tailed maggots and other pollution-resistant fish to future generations would be a grave folly indeed. Our children will have little need of oysters turned green and reeking of oil.

Photo © Fotogram, Paris - John Craven

Photo © BP, London



Oil may eventually provide man with major new sources of food. Scientists have found that bacteria, particularly yeast organisms, fed on petroleum can produce a protein flour that can be processed into a variety of tasty foods. Who knows? The oil pumps, left, may one day give forth chicken-à-la king or pâté de foie gras! Today, at any rate, oil-based yeast protein is already being used to feed new-born chicks, below.

THREE-STAR SYNTHETIC CUISINE

by Alexander Nesmeyanov and Vassily Belikov

IT is already possible to foresee the day when man will be freed completely from all recourse to animals for his food and clothing," wrote the distinguished Russian chemist Dimitri Mendeleyev, in 1875.

Subsequent achievements of science have confirmed the validity of this bold prediction by the scientist who established the Periodic Table of chemical elements. To a large extent, synthetic fabrics have today replaced natural textiles, and the next task for science is to increase—and change—man's food resources by creating synthetic foods.

ALEXANDER NESMEYANOV, *former president of the U.S.S.R. Academy of Sciences and member of its Praesidium, is founder and director of the Academy's Institute of Elementary Organic Compounds. For his achievements in chemistry and research he was awarded the State Prize in 1942 and the Lenin Prize in 1966. Professor Nesmeyanov is a member of many foreign scientific societies, including the Royal Society, London, the Royal Society of Edinburgh and the American Academy of Arts and Sciences.*

VASSILY BELIKOV *is a specialist in the field of amino acid synthesis and theoretical organic chemistry. He is head of the laboratory for the synthesis of nutritional substances at the Institute of Elementary Organic Compounds (U.S.S.R. Academy of Sciences).*

So far, chemistry has made no attempt to compete with agriculture. Instead, it plays an auxiliary role, seeking to provide agriculture with chemical fertilizers, pesticides, growth agents and products designed to preserve natural foodstuffs and improve their taste, appearance and digestibility. But basically, food production today is in no way different from what it was in the primitive communities of hunters and farmers.

And yet the role which organic chemistry could play in providing man with a profusion and variety of foods has long preoccupied many of the world's leading scientists.

Dimitri Mendeleyev (1834-1907) declared: "As a chemist I am convinced that we can obtain nutritive substances by a direct combination of elements contained in the air, water and soil, not by the ordinary methods of agriculture, but in special factories. If the need for this has not yet been felt, it is because unused land still abounds everywhere . . . and I believe that the day when the density of the world's population reaches alarming proportions, man will learn to use the colossal mass of sea water around him to provide abundant food, before resorting to the manufacture of

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More nourishing and cheaper

synthetic food. In all probability, the first factories will be for the cultivation of primary organisms, similar to yeast, by the use of water, air, minerals and solar heat."

A similar idea was advanced by the French scientist Marcelin Berthelot, a 19th century pioneer of chemical synthesis. "The day will come," he said, "when everyone will take for their meals a tablet of nitrogen, a small amount of fat, a little starch or sugar, and a bottle of aromatic flavouring, mixed according to taste. All these ingredients will be manufactured cheaply and in unlimited quantities in our factories. Food will thus be unaffected by good or bad seasons, neither by rain nor drought, neither by heat which withers plants nor frost which destroys all hope of their bearing fruit. Finally, all these products will be free from the pathogenic microbes which cause epidemics and threaten human life. When that day comes, chemistry will have brought about a revolutionary transformation in the world, the effects of which no one can foretell." ("Science et Morale," 1897.)

IS it still too soon to tackle the problem of creating synthetic foods? Let us take a look at a basic factor in the global equation of food and people: the needs of the individual human being in terms of nourishment?

Apart from water, man needs five groups of basic elements—proteins, carbohydrates, fats, vitamins and mineral salts. As daily nourishment, an adult should have, on average, two litres of water, 80-100 grammes of protein, 400-500 grammes of carbohydrates and 80-100 grammes of fats. As for vitamins (0.1 gr. a day, excluding choline, of which 0.1 gr. is also needed) and salts (20 gr. in all, including 10 gr. of cooking salt), the needs are small and can be easily met.

Synthetic foods must obviously include all the indispensable salts and vitamins which are already being produced on a large scale through chemical and microbiological processes. And with the present industrial manufacture of vitamins, it is clear that man has already entered the age of artificial, non-agricultural production of nutritious substances.

The role of the other three groups of elements is to provide the human system with energy and "building materials." The first function is largely carried out by carbohydrates and fats and the second by proteins. Here we have a major distinction between groups of nutritious substances.

The carbohydrates and fats which provide energy are burned up during assimilation and lose their original chemical identity. Certain components of these two groups are interchangeable and the groups themselves can largely be replaced and transformed one into the other, by the human organism.

Proteins are completely different. Turned into amino acids by the digestive system, they provide the body with the "bricks" which it needs to build its own proteins, of which eight out of a total of 20 (9 in the case of children) are indispensable. Food should contain all these amino acids in strictly controlled proportions. Proteins are thus the most expensive and deficient items in our human diet, their most valuable and rarest elements being the indispensable group of amino acids.

Any pronounced protein deficiency, particularly if it is due to the absence in the diet of one or more indispensable amino acids, results in specific vitamin deficiency diseases such as kwashiorkor. Once restored, the missing amino acid re-establishes the balance and leads to a striking increase in the nutritive value of many proteins of vegetable origin.

It should be noted that the synthesis of the protein component of food bears no relation, contrary to what one might expect, to the highly complex problem of synthesis of natural albumin. This is because the alimentary proteins undergo complete hydrolysis in the digestive system and go into the blood in the form of amino acids.

ONE can readily see, then, that the problem is reduced to either the microbiological synthesis of protein or the microbiological or chemical synthesis of amino acids which can then be used, in suitable doses, in the composition of synthetic diets.

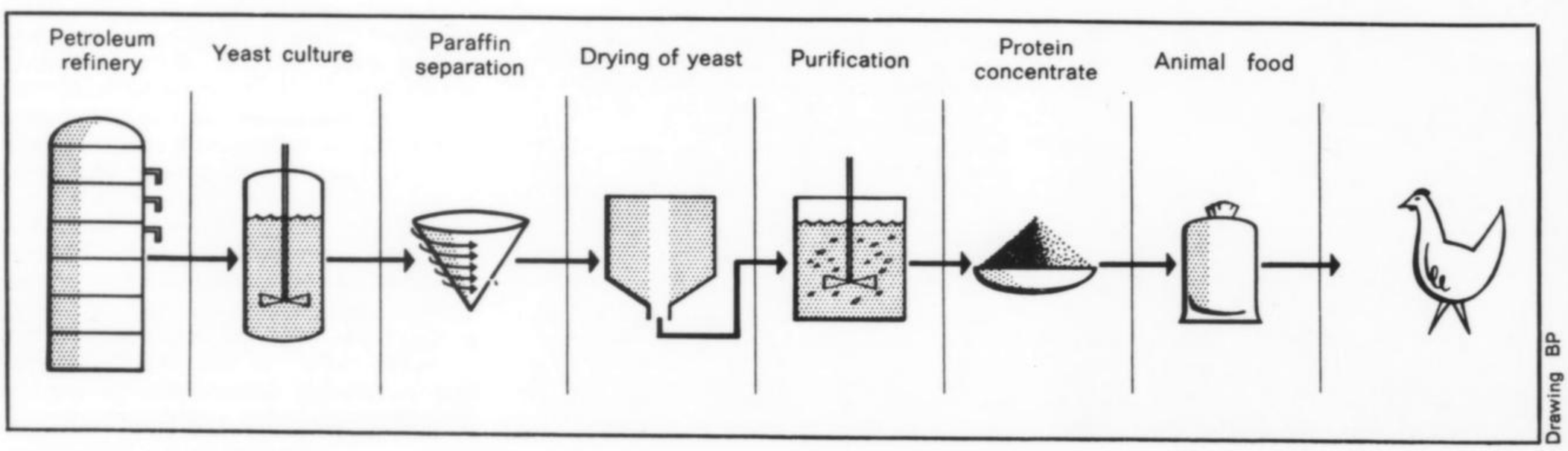
Such synthetic diets, consisting of amino acids, vitamins, minerals, glucose and linoleic acid ether, have been prepared by a U.S. scientist, Dr. Milton Winitz and tested on human beings over extended periods. They are used especially in the intravenous feeding of patients who, for one reason or another, cannot be fed normally.

Here we have a true model of synthetic nutriment. Apart from its strictly medical application, its real significance is in showing that it is possible to be nourished by a proper mixture of synthetic substances each ingredient of which can be obtained by synthesis.

Unfortunately the cost price of many

WHICH CAME FIRST, THE CHICKEN OR THE BACTERIA ?

Diagram below shows process used to convert petroleum into edible protein concentrate at a refinery in Lavera (France). Yeast organisms (single cell bacteria) feed from waxy paraffins in aerated tanks of crude oil. Yeast cells produced are then spun rapidly to separate them from the de-waxed oil which is returned to the refinery. Drying and extraction process then turns protein into a white and nearly tasteless powder, which can be incorporated into food. Extensive trials made by adding it to animal feed have been highly successful.



of them is still prohibitive which is explained by their limited production. Produced on a large scale and by more efficient methods, their price could easily be reduced, as has been the case with methionine, lysine and glutamic acid, the annual world production of which now exceeds 100,000 tons at a price of only a few dollars per kilogramme.

If all the other amino acids were manufactured at the same price, the daily needs per person would be met for about 50 cents. There is no reason why the reduction in cost could not be even greater—the present technique of producing amino acids, which is based on the cheap substance, nitromethane, seems very promising.

The Institute of Elementary Organic Compounds of the U.S.S.R. Academy of Sciences and the Pedagogical Institute of Leningrad, among other research institutes, have developed the synthesis of all the amino acids from this substance. No less encouraging possibilities are offered by the microbiological method, especially if the micro-organisms which produce amino acids can be switched from carbohydrate foods to hydrocarbons. A number of achievements in this direction have already been recorded.

APART from agriculture, another technique exists for the production of proteins on an industrial scale : that provided by microbiology. Scientists in a number of countries (including France, U.K. and U.S.S.R.) are already working on the production of fodder yeasts for which the raw material is provided by paraffins, one of the cheapest by-products of petroleum. Hydrocarbon yeast is exceptionally rich in protein. It contains over 40 per cent compared with the 30 per cent protein content of soya beans, the most nourishing of all agricultural products.

The French scientist, Alfred Champagnat, director of a Marseilles laboratory specializing in this research, was first to draw attention to the extraordinary possibilities of these yeasts in making up for the present protein deficiency: "The annual world shortage of animal protein can be estimated at three million tons. This corresponds to 15 million tons of beef cattle. For an annual production of 1,000 million tons of petroleum it can be assumed that 700 million tons are paraffin based. The production of 7 million tons of protein-vitamin concentrate, equivalent to 3 million tons of protein, would consume only 1 per cent of these 700 million tons of petroleum."

Why is it that researchers are more

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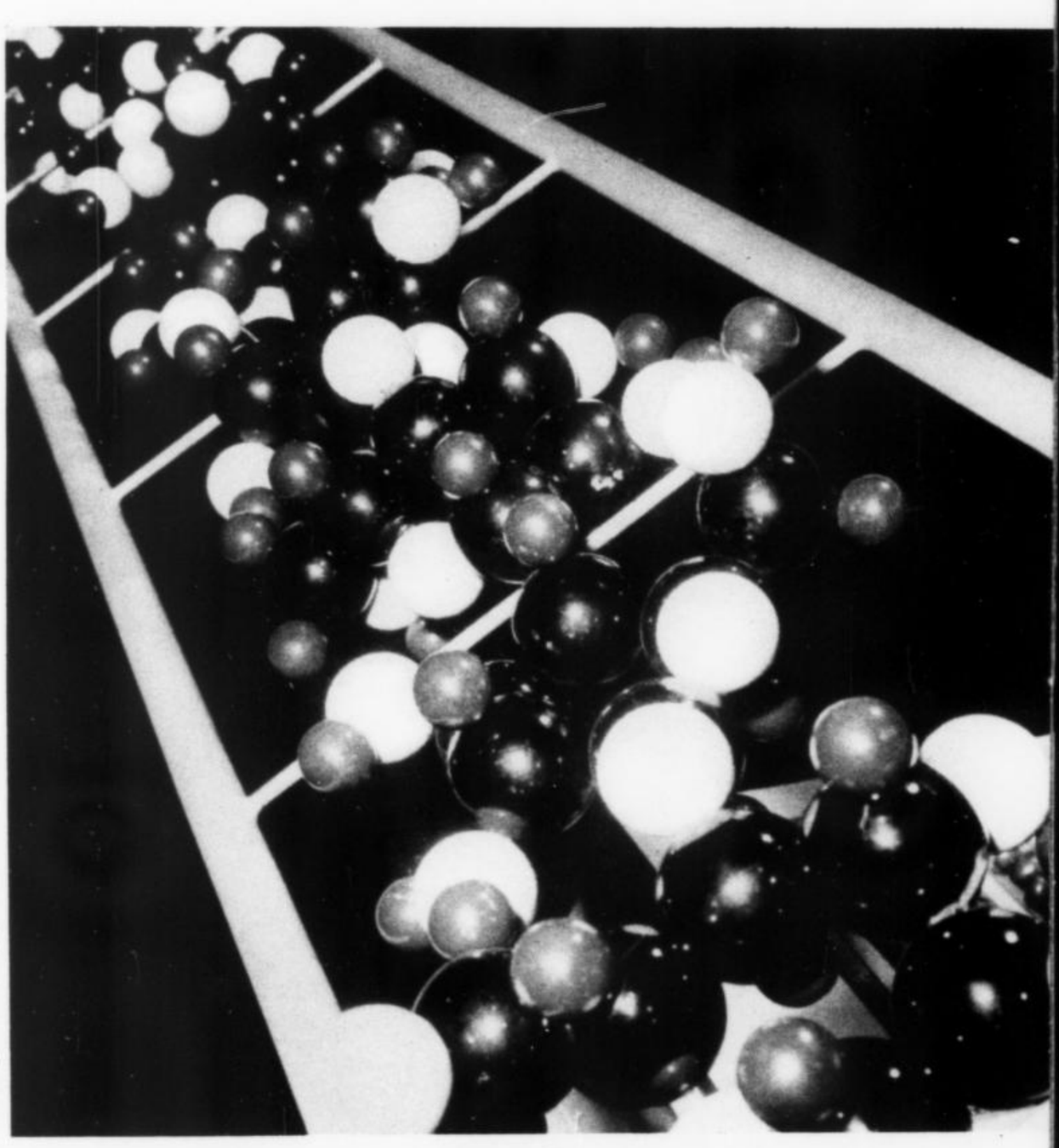
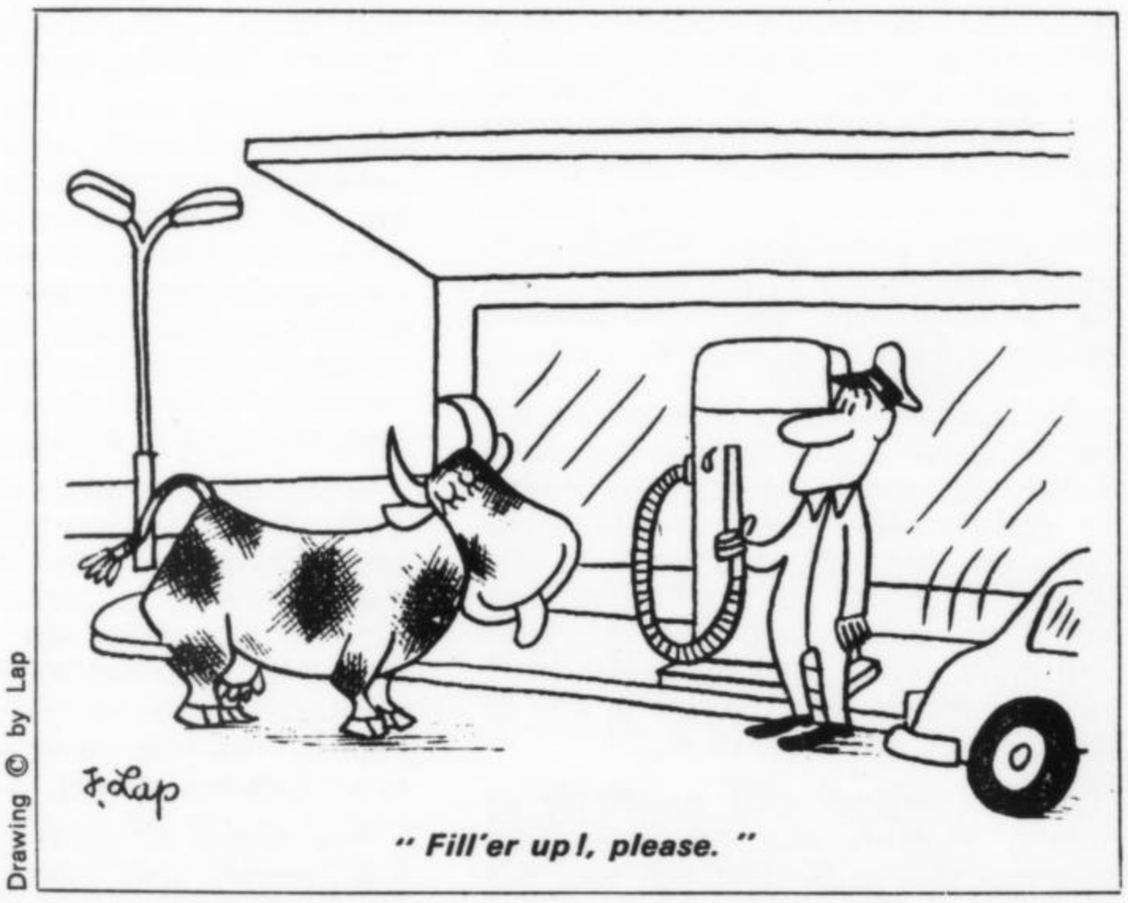


Photo © Kitrosser, Paris

Proteins as everyone knows are fundamental to life. Every minute in each of the hundred million million cells in the human body, protein molecules perform thousands of complex reactions to keep the cells alive and healthy. Scientists have closely studied the structure of proteins and their building blocks, the amino acids, which enable living organisms to synthesize proteins. This model from the Paris science museum, the Palais de la Découverte, shows the complicated chain-like molecular structure of a protein.

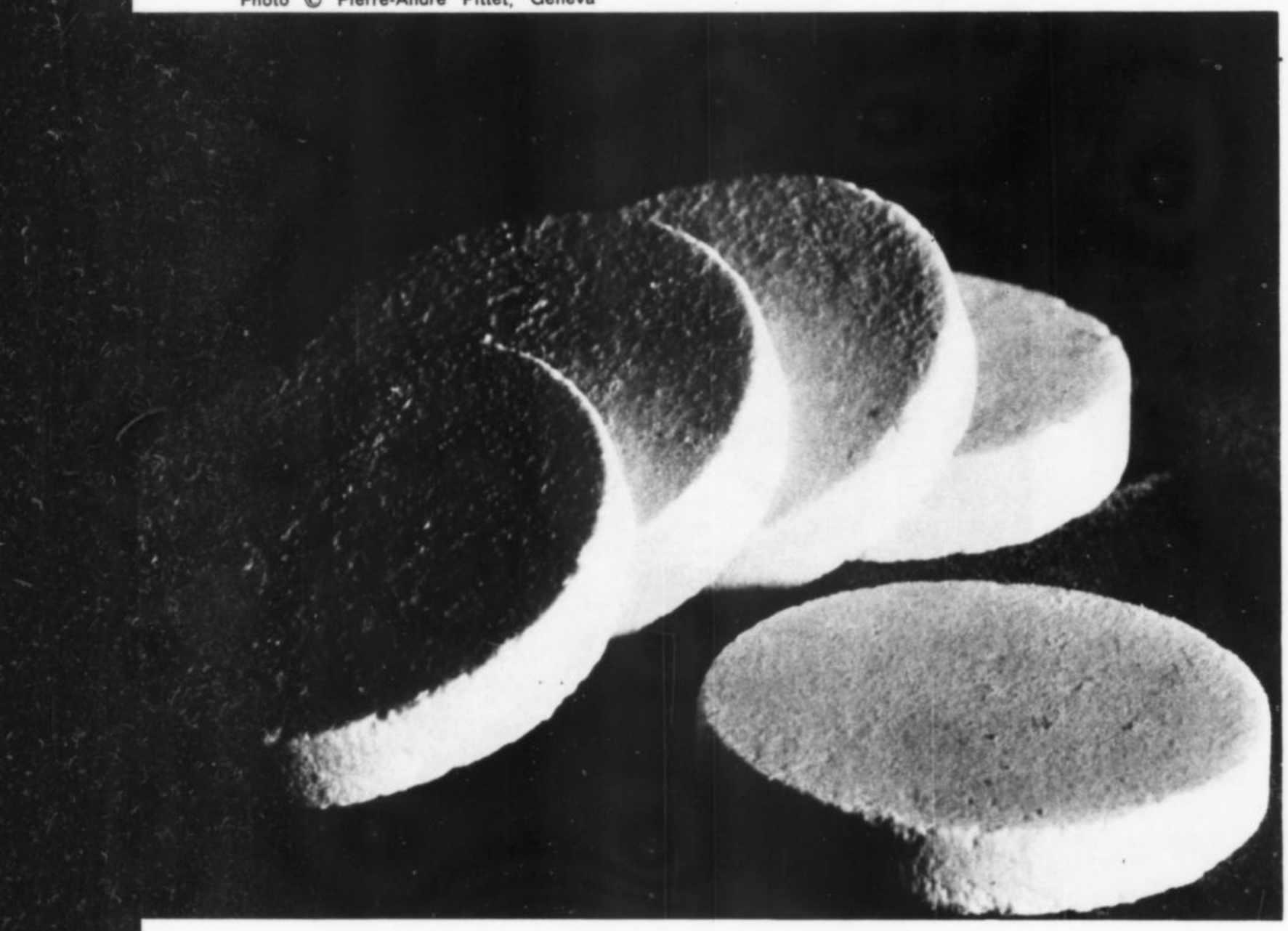


Drawing © by Lap

" Fill'er up!, please. "

Wafers, below, are one of the scientists' answers for more nutritious food produced in the laboratory. They are made from powdered milk, sugar and protein-rich oil. They are tasty too.

Photo © Pierre-André Pittet, Geneva



YUM, YUM! CHEMICAL CAVIAR. Only one of the dishes below is natural caviar (sturgeon eggs). The four others were produced in the laboratory from chemicals, yet few gourmets could tell which is which by taste or appearance. In recent years scientists have made phenomenal progress in duplicating natural flavours in artificially made foods. Right, a catch of sturgeon on the Don River, U.S.S.R.

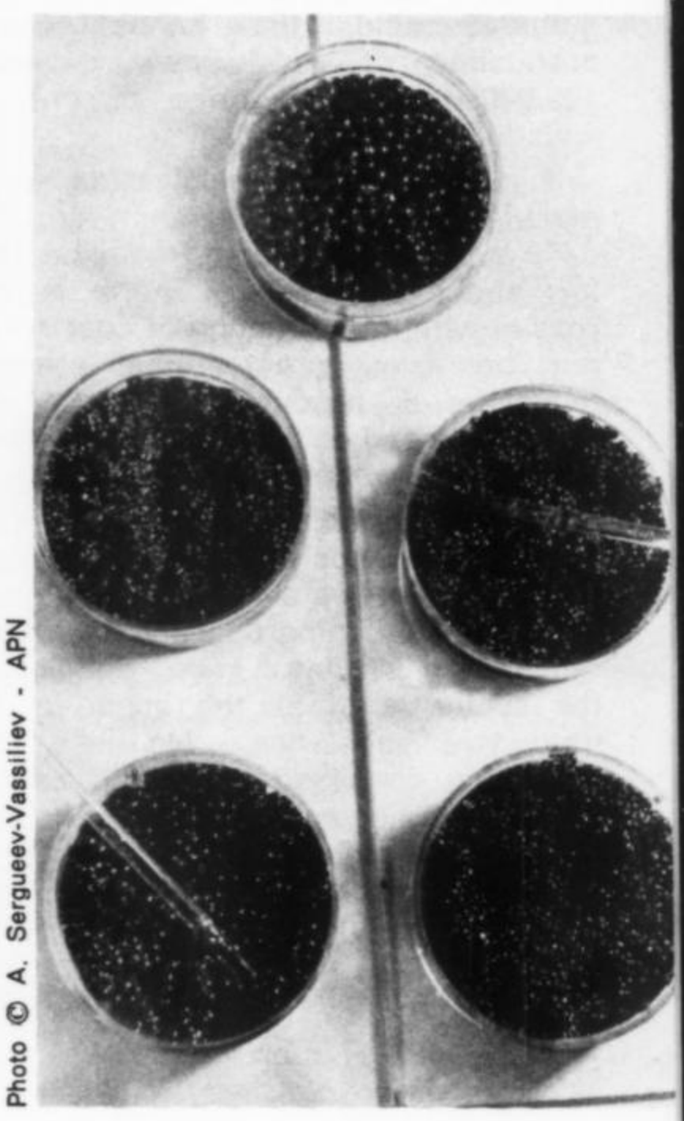


Photo © A. Sergueev-Vassiliev - APN

The new chemistry of the gourmet

interested in food for human consumption than in animal fodder? Here again, figures provide an explanation. Six million tons of synthetic protein are required annually to meet the needs of 250 million people; to nourish the same number of people with protein produced by stock farming would require the production of from 50 to 100 million tons of dehydrated protein to feed the animals themselves.

The problem facing chemists is the following: is it possible to transform a daily diet consisting of 100 grammes of protein, 450 grammes of carbohydrates, and 100 grammes of fats into food which, far from being less good and less varied, is even better and more varied than the usual fare? In other words, the problem is one of taste, smell and consistency.

In their original state, practically all natural proteins are odourless and tasteless due to the fact that they are macromolecular substances and consequently non-volatile and odourless. The same applies to starchy macromolecular carbohydrates and to fats. It is what is added to and mixed with our food which gives it a special smell and taste, and especially the substances formed in the process of cooking.

As we all know, the taste of any substance can be broken down into four main categories—sweet, salty, sour and bitter—which we identify through the taste-buds on our tongue. If we consider taste separately from smell, it is clear that any taste can be reproduced by a suitable addition of say, sugar, salt, acid and caffeine.

However, the question of smell is a much more delicate problem because smell combines with taste to form flavour, which is really what makes food appetizing. In our everyday fare, flavour is obtained by heating or the addition of local spices (onion, garlic, paprika, parsley, celery) or tropical ones (pepper, ginger, cloves, etc.).

The action of these substances is well known and corresponds to a simple principle. The effect of heating food is to form a mixture of substances giving off an attractive odour formed by dozens of volatile ingredients of which only a few are responsible for the specific smell. This aroma can be reconstituted either by mixing the same quantity of ingredients or by heating certain amino acids and their mixtures with different sugars.

We have found that the smell is enhanced when an unsaturated fatty acid is added to the mixture of amino acids. The characteristic odour of boiled beef or chicken casserole can be obtained in this way. Adding a trace of trimethylamino oxide produces the smell of salt water fish, and amino valeric aldehyde imitates the smell of boiled fresh water fish.

The final problem is that of the consistency of food. A variety of methods now exist for making sophisticated imitations of standard human foods from synthetic proteins. In the United States, certain firms are selling soya protein products which simulate various parts of chickens and different cuts of beef. Our Institute has developed a technique for making sturgeon caviar whose quality is practically indistinguishable from the real thing. In both cases, the methods used are borrowed from other bran-

Photo © I. Kogan - APN

ches of physics and the chemistry of macromolecular combinations. It can thus be seen that any alimentary protein can be turned into food which has the consistency and flavour of any animal protein.

Let us imagine the day when a country's economy is based on the manufacture of synthetic food instead of on traditional methods of food production. A few huge factories sited in different parts of the country where coal and petroleum are to be found, prepare all the food required by the population. Altogether, these factories occupy barely a few hundred square miles. Agriculture with its need for a vast labour force and its limited capacity for progress, has been abolished, with the exception perhaps of market gardens and horticulture.

There is no longer any need for the vast industry which formerly provided agriculture with its equipment—tractors, machines, tools. Nor for the metal used in making them, nor for the fuel used to power them. Nor for chemical fertilizers, pesticides, etc. A large proportion of the population previously engaged in these industries and in agriculture itself is thus freed for more productive work. Only a minute part of this manpower is needed for the production of synthetic food.

The old food industry gives way to an entirely new industry, infinitely more compact. No more bad years, poor harvests, unproductive land. No more calamitous losses due to climate, natural catastrophes, parasites, plant diseases, all of which today still take their toll of a considerable part of every harvest.

All the conditions are to hand for the transformation of villages into towns and towns into garden cities. Food products, ready to eat, packaged or tinned like the products on sale today, but with the fundamental difference that they contain the normal amount of vitamins and have the highest nutritive value, have only to be heated.

The appearance of these dishes leaves nothing to be desired. With a standard composition (proteins, carbohydrates, fats, salts, vitamins) adapted to each age need, these foods are the best source of health and energy the human system can have, infinitely better, at all events, than the best natural products.

No more obesity, no more fatty degeneration of the heart, liver and other complaints of the kind. At the least sign of physical abnormality, special diets can be composed with more or less of one or other ingredient.

Vast tracts of land previously reserved for crop growing give way progressively to forests and parks. The silting and drying up of rivers is stopped and the abundance of food products leads to the solution of the world shortage of drinking water which at present is steadily worsening.

The society of the future gains on all fronts: economic, social and also moral, as the slaughter of animals, a cruel vestige of the past, is progressively done away with.

Naturally, this is only a brief glimpse of stimulating problems for which solutions will need to be found by the joint efforts of chemists, biologists, doctors and economists. Whatever success, even partial, is achieved in this direction, those efforts will be repaid a hundredfold.

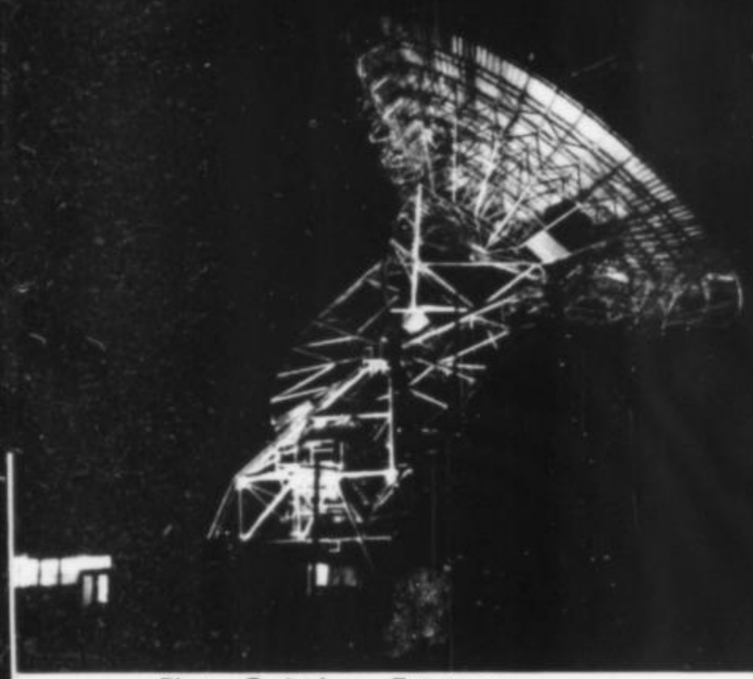


Photo © Andreas Feininger

Radio communication on the moon will be a serious problem with the lack of atmosphere and ionosphere. How can science solve this?

- **How will radio communication be established between the hidden face of the moon and the earth?**
- **How will research stations established on the moon communicate with each other?**

by Georges Phélizon

GEORGES PHELIZON *is director of long-term planning of the new applications of electronics at the Central Telecommunications Laboratory in Paris. From 1965 to 1968, he directed the development and construction of the European scientific satellite, ESRO I, launched into orbit on October 3, 1968, for the European Space Research Organization. Mr. Phelizon made a special study of the problem of communication on the moon for the conference of the International Academy of Astronautics, in New York in October 1968.*

THE recent success of Apollo 8, which circled the moon with three U.S. astronauts on board, was largely due to the power and quality of the remarkable telecommunications system planned and built by the U.S. civilian space agency, NASA.

The most spectacular feature of the service provided by the system was undoubtedly the direct transmission to the world's television networks of live shots showing life in the astronauts' cabin, the low altitude flight across the face of the moon, and the earth as seen from its natural satellite.

All this seems little short of miraculous when it is realized that the transmitter on board the spacecraft was no more powerful than that of a radio-taxi; at under 20 watts, it consumed hardly more power than an ordinary electric razor.

Just as the reflector in a car headlamp beams the light forward, the

reflector of Apollo's transmitting aerial beamed the radiated energy to the earth, and thus magnified its intensity about 500-fold.

But the moon is a long way off (240,000 miles, or nearly 10 times the earth's circumference) and over that distance radio waves are dispersed; so that they are so weak at the receiving end that they cannot be captured with an ordinary aerial.

With the aid of a parabolic dish 85 feet in diameter at the NASA station, at Goldstone, California their intensity was multiplied about 100,000 times. This dish is mounted on a swivelling base, and can be aimed with great accuracy. Two identical ground stations were set up at Madrid in Spain and at Canberra in Australia.

Because of the rotation of the earth, the moon appears to be revolving around every point of our planet, and the geographical location of the listening posts was therefore chosen to ensure that at all times at least one of these posts would be able to pick up the signals. The three stations were linked by a high-reliability network to the Mission Control Centre at Houston, Texas, which was thus in constant touch with the spacecraft as it moved across the moon.

Apart from the transmission of TV images and cross-talk between the astronauts and the flight controllers at the Houston mission direction centre, the telecommunications system played a vital part in ensuring the safe and successful accomplishment of the mission by keeping track of the spacecraft's position and speed with a high degree of accuracy.

The data it provided was fed to a battery of computers which, by comparing the spaceship's actual flight path with the flight plan, could immediately signal any correction needed to keep Apollo 8 on correct course. And indeed, one aspect of the success of this intricate earth-moon mission, i.e., the precision with which the whole operation was executed, is a triumph of the computer; credit is due to the scientists and technicians who built and programmed the computer units.

Thus, with the vital part played by radiocommunications in a reconnaissance mission such as that of Apollo 8 in mind, let us now look a few years ahead when man has established himself on the moon.

The short trips of 1969-1970 have been succeeded by longer and more sophisticated scientific expeditions. Lunar tourism, of course, is still a thing of the future.

The lunar environment is hostile to man; there is no atmosphere, and man can move about only if garbed in a space-suit. During the lunar day, which lasts a fortnight, the temperature rises to something like 150° C; by night it falls to about minus 150° C. From the moon, the "full earth" appears four times as large as the "full moon" familiar to us all.

LUNAR bases will probably be built in greater part underground, partly to offset the changes in temperature and partly to give protection against radiation or falling meteorites. Exploring parties of scientists will travel about in curious, highly functional vehicles.

For adequate scientific coverage, a number of bases will be needed on both the visible and the hidden sides of the moon.

Here again, the role of telecommunications in linking up the various bases and exploring parties as well as in connecting these lunar outposts with stations on earth will be of vital importance.

Radiocommunication conditions unfortunately are rather different from

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Below, a spectacle never before seen by man: the "rising earth" viewed over the sharply curved lunar horizon, photograph taken on Christmas Eve, 1968 by Apollo 8 astronauts. Left, radio telescope trained on the night sky.

Photo USIS

The moon's fickle gravitational field

those we are used to; while it is easy on earth to arrange for a caller in Paris or New York to talk by short wave radio-telephone to a passenger on a liner crossing the Atlantic, the same equipment would have a range of only a few score miles on the moon.

The chief reason is the absence of atmosphere on the moon; the earth's atmosphere plays an important part in using radio waves for communication purposes; the lower density of the air at higher altitudes acts somewhat like a prism, curving radio waves back to earth, and extending their range beyond the horizon. (There may well be planets where the atmospheric pressure is much higher than on the earth, in which case the prism effect would be so marked that radio or light waves would go right round the globe; this seems to be the case for Venus, in particular.)

However, the most important factor for long distance communication on the earth is undoubtedly ionospheric reflection; under constant bombardment by various particles and radiations (especially ultra violet rays) emanating from the sun, gas atoms in the upper atmosphere are robbed of some of their electrons.

When released, the electrons form conductive layers known as the ionospheric layers. These were deduced as early as 1910 and experimentally confirmed in 1925; they reflect back towards the earth the radio waves which would otherwise escape.

Fortunately for space communications, the ionospheric barrier is not insuperable, and chiefly affects wavelengths of roughly over six metres, that is, frequencies under 50 megahertz per second.

It can thus be understood why the radio-telephone which makes it possible to reach a liner in mid Atlantic

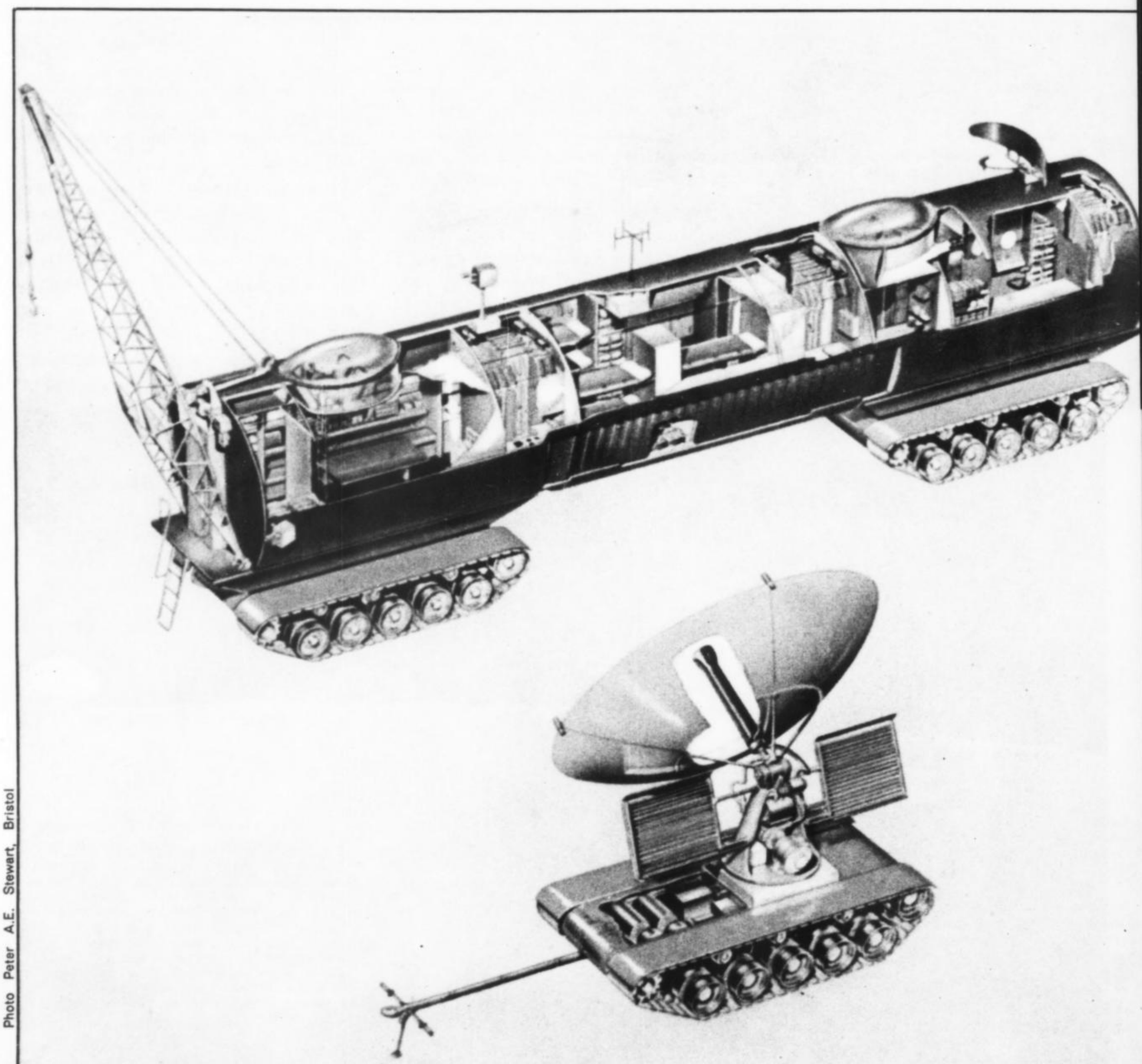
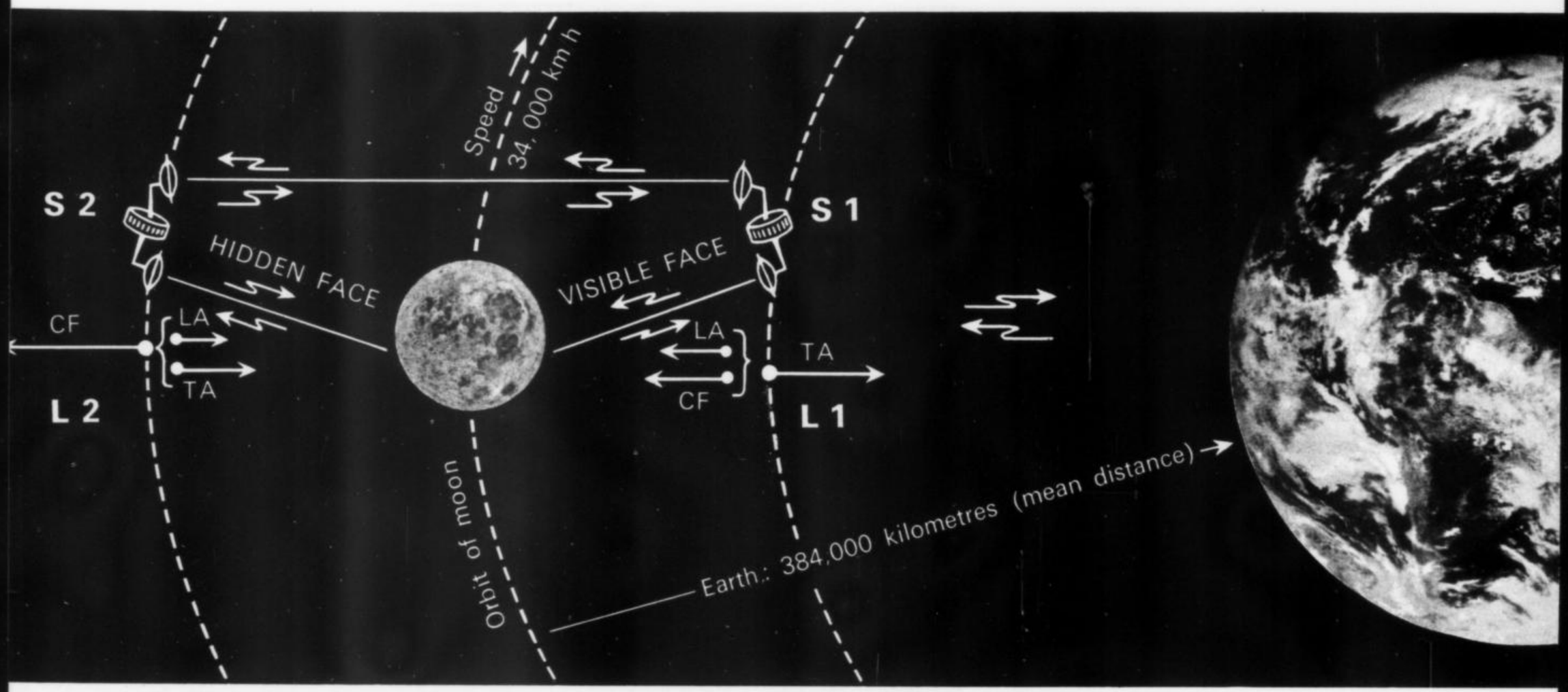


Photo Peter A.E. Stewart, Bristol



This diagram shows how two communication satellites, S-1 and S-2, could enable stations on the hidden face of the moon to communicate with the earth, and provide a radio link between research stations anywhere on the moon. These relay satellites could be established at certain points where the earth and moon cancel out each other's gravitational attraction (known as libration points), requiring only minimum corrections from time to time to keep them in position. The relay satellites would be placed in orbit at about 60,000 kilometres from the moon. At L-1, the lunar attraction LA combined with the centrifugal force of the satellite CF would balance the terrestial attraction TA. At L-2, the lunar attraction LA and the terrestial attraction TA offset the centrifugal force CF and would maintain the satellite in position. (Diagram is not drawn to true scale).

would be useless on the moon, where there is neither atmosphere nor ionosphere, so that all radio waves on the moon would escape freely into space. This is precisely one of the reasons why scientists are interested in installing radio-astronomy laboratories on the moon, as the "radio sky" would be clear for all frequency ranges.

Does this mean that lunar explorers, will be completely cut off from the earth ? The answer, fortunately, is no, since communications satellites provide a solution. Waves reflected by the ionosphere cannot ensure the regular transmission of high quality TV images whereas satellites can do so even for intercontinental programmes.

It will thus suffice to put a number of satellites in orbit round the moon to link up the scattered bases; but here again, conditions are not the same as on earth. The first TV relay satellites, placed in terrestrial orbit a few thousand miles up, girdled the earth in a few hours; they could therefore connect only two stations at certain times and for very short periods. It was then decided to increase the height of the orbit and with it the orbital period, i.e. the time taken to make one complete revolution.

The Molniya satellites developed by the Soviet Union, for example, follow a pronounced elliptical orbit thus considerably extending the time available for transmissions, which in the case of a link via satellite between Paris and Moscow can be maintained for up to six hours.

If the orbit chosen is a circular one at an altitude of 22,500 miles the orbital

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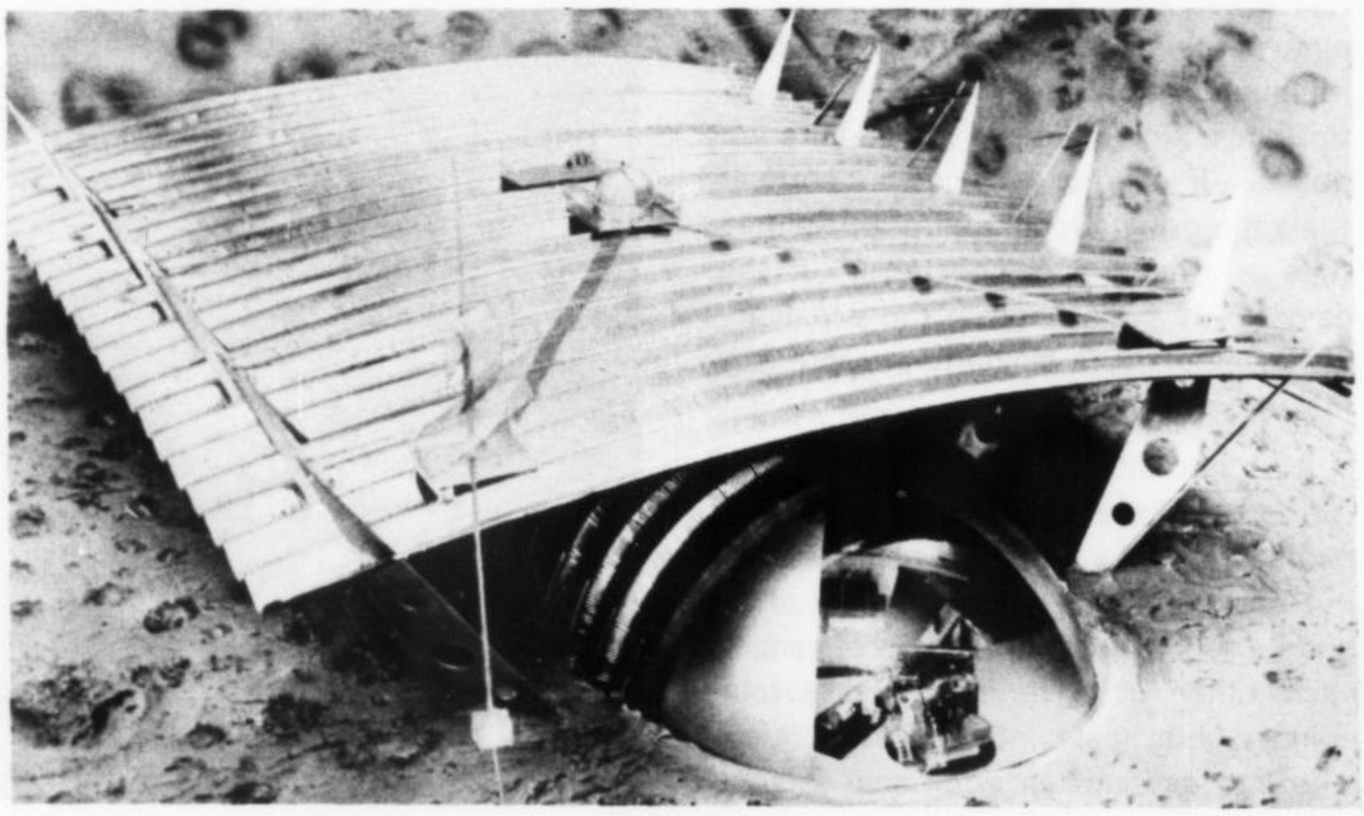

Scientific expeditions travelling across the moon's surface will need specially-designed vehicles. Conventional lubrication would be useless since oil evaporates in the prevailing vacuum. Rubber tyres would crack or fry in temperature extremes. Above all, mobile machines will have to negotiate difficult terrain. Photo left, two British designs by Peter A. E. Stewart for lunar surface vehicles. Top, mobile lunar laboratory moves on tracks and has observation domes and living quarters for crew. Below it, a mobile radio station with disc antenna. Photo right shows model of an American lunar scientific station: the large metal roof protects it from meteorites which hit the moon at extremely high speeds. In foreground, observatory under transparent dome.

Photo USIS

Sail-powered satellites operating on solar radiation

period will be 24 hours; such a satellite, launched on an east-bound equatorial orbit, will take just as long to go round the earth as the earth takes to spin on its axis: it will thus appear stationary. This is the case for "Early Bird" stationed above the Atlantic at 27 degrees West. A stationary satellite will thus permit permanent connexions to be established, and it is very tempting to transpose this solution to the moon.

But, as everyone knows, the moon takes 28 days, not 24 hours, to rotate on its axis, which is why it always turns the same face towards us, the other side remaining invisible from the earth; for a satellite to revolve round the moon in 28 days, it would theoretically have to be placed in orbit nearly 62,500 miles up. In actual fact, this would be possible only if the moon were isolated in space, as the attraction of the earth completely alters the situation. A satellite placed in such an orbit would rapidly escape from the moon's gravitational field.

ONE possibility would be to place our lunar communications satellite near enough to the moon for its attraction to exert a greater pull than the earth's; a suitable height would be something over 3,000 miles, giving the satellite a revolution of about 12 hours. The satellites would then revolve much faster than the lunar stations, and for quasi-permanent liaison, a dozen satellites would be needed.

Another conceivable solution which has great appeal, as it leads back to almost stationary satellites, utilizes a relatively simple phenomenon of celestial mechanics known as libration points. If a body is close to earth it feels the gravitational pull of our planet (this is what we call weight). If the same body finds itself in the proximity of the moon, it is similarly attracted by the force of the moon.

It is not difficult to imagine, therefore, that there is some intermediary point where the force of attraction of the earth and the moon are equal in both directions, and therefore cancel each other out. In determining this point, actual calculations made also take into account an additional factor: centrifugal force which tends to pull an object away from the earth, since the body together with the moon rotates around the earth in 28 days.

Diagram on page 29 shows the first libration point L-1, at about 34,000 miles from the moon in the direction of the earth. It also shows a second point L-2, off the hidden side of the moon, where the centrifugal force counteracts the combined attraction of the moon and the earth. If a satellite S-2 is placed at L-2, it will thus be able to serve nearly all the bases established on the hidden face of the moon, but will not allow communication with the earth which is not visible from this point, since it is hidden by the moon.

Man's creative genius has overcome this difficulty: satellite S-2 will not be placed exactly at L-2; it will be shifted a few thousands miles sideways, so as to be in sight of the earth; and even perhaps of L-1, where a second satellite S-1 will relay communications to the stations on the visible face of the moon.

For both S-1 and S-2 to remain stationed near the selected positions will require the use of an extremely low-powered position-correcting device

Photo © APN - V. Lebedev

(less than 1 milligramme force per kilogramme of satellite).

Such a low thrust can be produced by ion engines, but another possibility is to stabilize the satellites with sails.

In "The Planet of the Apes," by Pierre Boulle, the two chief characters roam across interplanetary space, propelled by the pressure of the sun's rays on the sails of their spacecraft. Some American scientists have seriously considered equipping satellites placed near the libration points with sails which would maintain them in position thanks to the pressure of solar radiation.

The satellites would in fact describe a small individual orbit around the libration points to allow for the changes in the moon's and earth's position in relation to the sun in the course of the year. Calculations have shown that a sail area of one-third of a square metre per kilogramme of satellite would be sufficient to produce the force needed.

To install on and around the moon all the components of the communications networks briefly described here will demand many years, but this does not mean that the first scientific missions will be deprived of the means of communication. The powerful communications system installed on the earth to keep in touch with spacecraft could provide similar services to moon stations on the visible face of the moon, and could also be used even to interconnect them. In that case, since the velocity of radio waves is 187,500 miles per second, a lapse of about five seconds between question and answer would have to be allowed for in telephone conversations between two points on the moon via the earth.

Of course, other means of communication used on earth before the satellite era began could also be used on the moon. But it appears unlikely that they will be used to link points more than a few dozen kilometres apart.

AWAY FROM THE EARTH

"Away from the Earth II", kinetic painting by Frank J. Malina, showing the trajectory of a satellite leaving the earth and orbiting the moon (right).

Left, boosted aloft by the tremendous power of its rocket engines, a spacecraft blasts off from a Soviet cosmodrome.

Photo Unesco - Dominique Roger

THE most simple idea would be to lay a telephone cable on the lunar surface, but the operation would be far from easy.

Another possibility would be to use pylons brought from earth, or the mountains of the moon to install radio relays similar to those first used around 1950 as boosters for long distance TV transmissions through microwave radio links. But as the moon's radius is only a fourth that of the earth, the transmission range would be only half that on earth, and a larger number of relays would be needed. Each relay would also have to contain its own long-duration unattended electric power supply. This of course will be rather difficult in the lunar environment.

Finally, we must not forget that every piece of equipment used on the moon will have to come "from the sky." As the moon has no atmosphere, the only way to slow down a lunar-bound spaceship is to brake it by firing a rocket engine. So it may be more economical to use equipment placed in lunar orbit rather than land it on the moon. Another consideration is that climatic conditions in lunar orbit may well be far more temperate than those on the moon's surface.

Both these factors point to satellites as the best solution, and in our opinion the full scale use of lunar bases, particularly on the hidden side of the moon, will not be feasible until such time as communication satellites have been set up in the vicinity of the moon.

THE NEW FOOD REVOLUTION *(Continued from page 12)*

decade in the conversion of fish into seafoods for indirect or direct human consumption have been little short of spectacular. Large quantities of fish are now converted into meal, which is in turn indirectly consumed in the convenient protein form of meat, eggs and chicken.

Fish protein concentrate (FPC), a high protein powder made from otherwise inedible fish, is also highly suitable for direct consumption by people. FPC is dry, can be stored indefinitely and transported conveniently without wastage. Both tasteless and odourless it is suitable as an additive to other foods such as breakfast cereals. Added to animal foods, it will lower the production cost of meats, poultry and eggs by shortening the growing period and improving their quality.

EVEN more important investigations are currently being made in the U.S.S.R. and Japan into the possibilities of exploiting the vast quantities of Antarctic krill, *Euhausia superba*. This small shrimp, about five centimetres long, is the main food of the balloon whale. Rough calculations, based partly on estimates of the quantities that must have been eaten by whales before whaling drastically reduced their number, suggest that the annual yield of krill could be at least 50 million tons—or about the equivalent of the entire world fish catch at present.

Soviet experiments show that catching the krill in quantities may be quite easy and that an acceptable form of meal for animal feeding can be produced. A more interesting prospect is that, if the technical problems of separating the meat from the shell can be resolved, krill may be used for direct human consumption. Properly presented, in the form of imitation lobster tails, for example, it would appeal to the rapidly growing number of consumers of the much similar prawns, shrimps and other crustaceans.

Much has been made these days of advancing fishing from the primitive stage of hunting to the stage of agriculture. All the many forms of farming —pastoral, ranching, intensified gardening and factory farming—have their marine equivalents. Oysters, mussels and shrimp have long been raised in shoreline ocean beds and on ropes suspended from special rafts, just as the Japanese systematically have for centuries raised and harvested large quantities of *nori* (a highly nutritious edible seaweed) in their bays and inlets. And recently in Britain there has been an increasing interest in intensive marine farming of battery plaice and sole.

The importance of sea farming is primarily that fish can be raised with relatively cheap food. Unlike chicken, which can have no more than about 5 per cent of fish meal without tasting of fish, the diet of plaice or sole can presumably contain much more fish meal or other products—including perhaps meal from krill.

Last autumn, a subsidiary of an Anglo-Dutch food-detergents manufacturer, put the first crop from its fish farm at Loch Ailort in the western Scottish Highlands on the U.K. market. In its initial stage of fish-raising, the firm is now concentrating on raising rainbow trout—but with a difference. Trout farming in fresh water is a well-established industry in many countries. But Loch Ailort trout are raised in sea water and the largest—a little over two years old—tip the scales at 5.5 lbs. each. Not only do the salt water trout get bigger faster, but due to the careful regulation of their diet, the trout have delicate pink flesh resembling salmon.

Understandably, these pioneer efforts in fish farming have been concentrated on the highest priced varieties, but with a fish farm of eight square miles able to produce more fish than are presently caught in the entire North Sea, the business could soon take on massive proportions including a wide variety of popularly priced seafoods.

This emergent *aquicultural* revolution has its parallel in British *agriculture*, and Britain's "convenience" food industry has played a major role in both. The experimental and developmental fish farming was a logical outgrowth of the heavy investment in the British frozen foods industry.

To meet the tight standard specifications, the introduction of new varietal strains and improved growing techniques have also produced substantial yield increases in all crops grown under contract for the convenience food industry. Pea yields, for example, have risen by more than 40 per cent while other crops such as spinach and broad beans have increased even more.

Forward planning of the industry, with its ability to forecast sales and plan production tonnages, has brought a measure of stability to vegetable growing never before known. Likewise, as a result of the development of convenience foods, average output of poultry in Britain more than doubled during the past ten years.

But a comparison of per capita British consumption of frozen foods in 1967 (11.4 lbs.) with consumption in the U.S. (68.0 lbs.) indicates that the convenience food revolution in the U.K. has just really got under way. And the same conclusions can be drawn for Sweden (22.7 lbs.), Switzerland (15.4 lbs.), and Denmark (11.4 lbs.). In all other European countries and the lesser-developed countries it has hardly begun. What is true for frozen foods, largely holds for the entire range of convenience foods and the catering industry.

Consider further that the U.S. is on the threshold of still another stage in the revolutionary development of the convenience food industry. What are considered convenience foods now will be dwarfed by what will be accepted as convenience foods only a decade from now.

In spite of the critical dimensions of the world food situation at present, food production is already the world's greatest success story. Most developed countries have solved their basic problems—with the possible exception of the problem of mounting surpluses.

THIS great achievement of the past two decades can be attributed to reliance, not on grandiose theories, but on treating food production as a business—from the farm, to the processing stage and distribution—all requiring respected skills and capital inputs which are essential to ultimate success.

FAO Director-General Addeke H. Boerma recently said that he saw no intrinsic reason why yields in most developing countries should not grow at the same rate as those in the advanced and largely temperate areas.

Nature has been "reasonably impartial" in distributing her riches, both natural and human. We have the knowledge of technology, and, hopefully, the understanding of human nature necessary to assure that the world will in the future be well fed. Through the close co-operation of governments and private business, of all nations, the last three decades of the twentieth century can go down in history as the age of the revolution that achieved this monumental feat.

UNESCO NEWSROOM

World anti-pollution conference

Sweden, supported by 50 co-sponsoring nations, has asked the United Nations to organize an international conference in 1972 on man's pollution of the world. Sweden hopes the conference will promote measures against contamination of the environment, dispel public ignorance and apathy towards this increasingly critical problem, and also cut down costly duplication of world pollution research while giving it a common outlook and direction.

Norway aids Indian cancer project

One million kroner has been given by Norway to India for a new, "early detection" cancer control project near Madras (80 per cent of India's cancer patients seek help too late). Under the scheme, 100,000 people will be examined.

Rabies menace

Rabies caused 637 deaths in 92 countries in 1967, 62 less than in 1966. But these WHO figures represent only one-fifth to one-tenth of the actual deaths caused by rabies. Sixty-three countries report rabies on their territory, and 560,000 people have received anti-rabies vaccinations. Foxes, dogs, bats and skunks are major carriers of the disease.

Population growth vs. economic growth

To help developing countries reduce population growth, and so speed up economic development, the World Bank has set up a new programme to finance facilities for family planning projects, and to co-operate in research on the most effective family planning methods.

Japan's 'talking' computer

A major breakthrough in computer development has been made at Kyoto University, Japan where scientists and engineers have developed a "talking" computer. The main innovations are, an automatic translating device which has memorized the grammatical rules of English and Japanese, and a voice-producing mechanism with 550 vocal factors. When a question in English printed on tape is fed into the computer, its mechanical voice can either translate the question, or give the answer in Japanese.

Lilliputian carving in ivory

An almost incredible piece of miniature ivory carving is featured in a current exhibit at the National Palace Museum at Taipei, Taiwan (Republic of China). It consists of an outer box no larger than 1.68 by 2.9 by 3.48 centimetres with nine smaller boxes inside, all with different latticed decoration. Water-chestnuts, pomegranates, mushrooms and "Buddha-fingers" (a fruit), no longer than .3 centimetres are stored in the boxes, some attached to chains as thin as a piece of thread. Also on display are miniature animals of jade and semi-precious stones and diminutive albums of paintings and calligraphy, all selected, like the box, from the collection of trinkets, curios and miniatures of an 18th century Chinese ruler, Emperor Ch'ien-lung.

'The rights of man'

"The Rights of Man", a strikingly illustrated book inspired by the Universal Declaration of Human Rights, has just been published in Australia. With drawings by Eva Sandor and explanatory text by Georgette Coty, two Hungarian-born Australian citizens, the theme of the work is man's struggle to establish his rights as a human being. (Publisher: F.W. Cheshire, Melbourne, Canberra, Sydney, 1968; price, A$ 4.50).

Flashes...

■ *Britain spends 2.7 per cent of its gross national product on scientific research and by next year will have more than 180,000 scientists and research workers (twice as many as in 1958).*

■ *In 1967, Japan was the world's leading film producer with 719 feature films. India was second (316), and the Republic of China (Taiwan) third (257), according to the Unesco Statistical Yearbook.*

■ *The U.S.S.R. Academy of Sciences recently published a two volume atlas of the Antarctic, containing more than 300 maps, tables and diagrams.*

■ *Zambia has become the 100th member state of the International Atomic Energy Agency.*

■ *World school enrolments rose 86 per cent between 1950 and 1965; primary schools by 72 per cent; secondary schools by 139 per cent; higher education by 185 per cent, reports the Unesco Statistical Yearbook.*

U.N. Institute for Training and Research

The first U.N. commemorative stamp for 1969, issued on February 10, commemorates the work of the U.N. Institute for Training and Research (UNITAR). Founded in 1965, UNITAR trains personnel, particularly for developing countries, and conducts research into such U.N. problems as the transfer of technology to developing countries and the problem of the migration of skilled personnel to affluent nations. The new stamp appears in six and 13 cent denominations. As agent in France for the U.N. Postal Administration, Unesco's Philatelic Service stocks all U.N. stamps and first day covers currently on sale. For further details, write to the Unesco Philatelic Service, Place de Fontenoy, Paris-7e.

BOOKSHELF

UNESCO'S TRANSLATIONS SERIES

U.S.S.R.

■ **Apples of Immortality**
Folk Tales of Armenia
By Leon Surmelian
Allen and Unwin, London, 1968 (45/-)

INDIA

■ **The Gift of a Cow**
A translation of the Hindi novel "Godaan" by Gordon C. Roadarmel
Allen and Unwin, London, 1968 (45/-)

NORWAY

■ **The Palace of Ice**
By Tarjei Vesaas
Translated by Elizabeth Rokkan
William Morrow and Co, Inc., New York, 1968 ($4.50)
Published under the title, "The Ice Palace", by Peter Owen, London, 1965 (25/-)

JAPAN

■ **Essays in Idleness**
The "Tsurezuregusa" of Kenko
Translated by Donald Keene
Columbia University Press, New York and London, 1967 ($6.50)

★

LANGUAGE AND LANGUAGE LEARNING

■ **The Scientific Study and Teaching of Languages**
By Harold E. Palmer
Edited by David Harper
Oxford University Press, London, 1968 (16/-)

■ **Language in Education**
The Problem in Commonwealth Africa and the Indo-Pakistan Subcontinent
By Julian Dakin, Brian Tiffen and H.G. Widdowson
Oxford University Press, London, 1968 (13/6)

★

■ **Fukuoka Unesco** (No 4, 1968)
Proceedings of the Second Kyushu International Cultural Conference, 1967, on the subject of Japan's modernization and the role of Kyushu, Japan's most populous island, in this process.
The Fukuoka Unesco Association, Maruzen Bldg., 7-20 Tenya-Machi, Fukuoka, Japan.
Full report in Japanese ($5.00); offprint in English (abridgement, about 95 pages, $2.00)

■ **The Indian Mind**
Essentials of Indian Philosophy and Culture
Edited by Charles A. Moore (1967, $9.50) A companion volume to "The Chinese Mind" and "The Japanese Mind," published by East-West Center Press, Honolulu, Hawaii 96822

■ **New Guinea**
The Territory and its People
By D.A.M. Lea and P.G. Irwin
Oxford University Press, London, 1967 (43/-)

■ **Everyday Health**
By Eira Grewer
The Commonwealth and International Library, Pergamon Press, Oxford, 1965 (12/6)

Letters to the Editor

LIFETIME OF PUNISHMENT

Sir,

In your issue on Human Rights (November 1968), you published the picture of a slave wearing a kind of muzzle over his mouth. In my opinion the poor man was made to wear the device not as a punishment, but to prevent him from eating soil.

In many countries slaves were always hungry and many tried to fill their stomachs with soil; in the long run this caused their death.

Their whole life was a punishment.

Jan Müller
Amsterdam, Netherlands

REGRETTABLE OMISSION

Sir,

From its title, "Human Rights", I expected the "Unesco Courier" for November 1968 would prove to be an outstanding number. On reading it, I was greatly upset by an omission which to my mind is both incomprehensible and inexcusable.

The passages you published from "The Right to be a Man" quoted the words of Gandhi, Marx, Mohammed and the Talmud, among other sources, but not a single word of Jesus Christ, who sacrificed his life for the salvation of mankind.

This omission is indeed regrettable in a magazine of such broad scope and readership.

Lucien Moulin
Al-Attaf, Algeria

See "The Golden Rule", December 1968 issue, page 49—Editor.

FREDERIC JOLIOT-CURIE AND THE ATOM

Sir,

I was interested to read your issue, "Peaceful Uses of the Atom" (July-August 1968) which summarizes present achievements in this field and outlines prospects for the future. But I was sorry to find no mention of Frederic Joliot-Curie.

This great French scientist spoke out against any use of the atom other than for peaceful purposes. As early as 1949 he declared: "If in the future I want to be able to engage in research, and if I want young people to be able to devote themselves to research without misgivings and under the best conditions, it will be necessary to build a society which recognizes the true role of science, a society in which war will not only be impossible, but unthinkable. This responsibility I cannot delegate to others and, in the final analysis, it is science itself that I am defending."

The article by I. H. Usmani (Charting the Nuclear Labyrinth) retraces the history of research on artificially created radioactivity, but omits any reference to the work of Irène and Frédéric Joliot-Curie in 1934, which earned them the Nobel Prize the following year.

The author mentions the research of the German scientists, Otto Hahn and Fritz Strassmann, who discovered that when slow neutrons hit uranium 235, the nucleus splits in two, releasing energy. The research of Hahn and Strassmann, in fact, began where that of P. Sairtch and Irène Joliot-Curie left off. Moreover, reservations were expressed on the results of their experiments. It was Joliot-Curie who immediately formulated the fundamental theories on fission, who invented the apparatus which demonstrated the reality of the phenomenon and who photographed the trajectory of a particle produced by fission. The way to the use of atomic energy was finally opened by Joliot-Curie's research with Halban and Kowarski in 1939.

In my view, failure to give these facts shows a lack of objectivity. It is to be regretted that Joliot-Curie was ostracized in his own country for declaring that his work on the atom would be devoted solely to peaceful research, and a similar ostracism should not be shown by a magazine which, according to its own definition, is "a window open on the world," and which, in its July-August 1968 number, merely restated the general principles formulated by this distinguished and deeply humanistic scientist.

Roger Magois
Houilles, France

THE FORCE OF PUBLIC OPINION

Sir,

Unesco strives unremittingly to accomplish its great mission, so that everyone may enjoy the right to education, so that all men, transcending frontiers and continents, may learn to understand and respect one another, so that the vestiges of the past may be preserved to enrich a world cultural heritage.

The "Unesco Courier's" task—and major responsibility—is to make those efforts known as widely as possible and to promote international understanding. To this end, it is better for the magazine to eschew political problems and to open its columns to authors from every country, expressing every view-point.

When basic human rights are violated, however, the "Unesco Courier" does not remain silent. In its March 1967 number, it took a positive stand against the policy of Apartheid in South Africa. In "30 Questions on Human Rights" (January 1968) it stated: "The main instrument at the disposal of the international community... is exposure to world public opinion." And in the same issue, Sean MacBride wrote, in "The New Frontiers of International Law," "No dictator or authoritarian regime can now remain immune from the impact of world public opinion."

This applies not only to racial discrimination but to every other violation of human rights.

All free men and women are still shocked by recent events in eastern Europe. A small country which set out courageously to chart its own course was occupied by foreign troops; a government vested with the confidence of an entire people—a rare phenomenon indeed—is no longer able to take its decisions freely. How can we reconcile these events with the image of the Soviet Union presented in your November 1967 number, "U.S.S.R. Today?"

Little courage is needed to protest against the racial policy of South Africa. It is isolated and shunned by other nations. It takes far more courage to condemn the intervention in Czechoslovakia. I know that a number of agreements and conventions can be quoted to justify the legality of this intervention. But, legal points apart, the fact remains that the occupation of Czechoslovakia, viewed objectively, is a blow against human rights.

This occupation is not an internal matter for the socialist countries. If such were the case, then the policy of Apartheid could equally well be considered as an affair that concerned South Africa alone. The occupation of Czechoslovakia is a very different question, an event that vitally concerns all who are resolved to preserve the rights and liberties they hold dear.

I would ask you to add your support to public opinion. Condemn without reserve the occupation of Czechoslovakia, so that when we look back on International Year for Human Rights, 1968, we may do so without a sense of shame.

Andreas Freivogel
Riehen, Switzerland

IN THE EPIC TRADITION

Sir,

Congratulations on the issue devoted to the "Two Great Epics of Asia, *Ramayana* and *Mahabharata*," (December 1967). I have just re-read your brilliant and unusual account of these two great Eastern epics. I personally am a lover of the epic tradition in literature. The study of literature must begin from sources which are close to a people, a nation, a civilization. Would that more such studies were carried out for the benefit of all people proud of an undying and rich culture and tradition. Would a similar treatment of the Greek epics—*Iliad* and *Odyssey*—be possible in your magazine?

Jay Naidoo
Durban, Natal, South Africa

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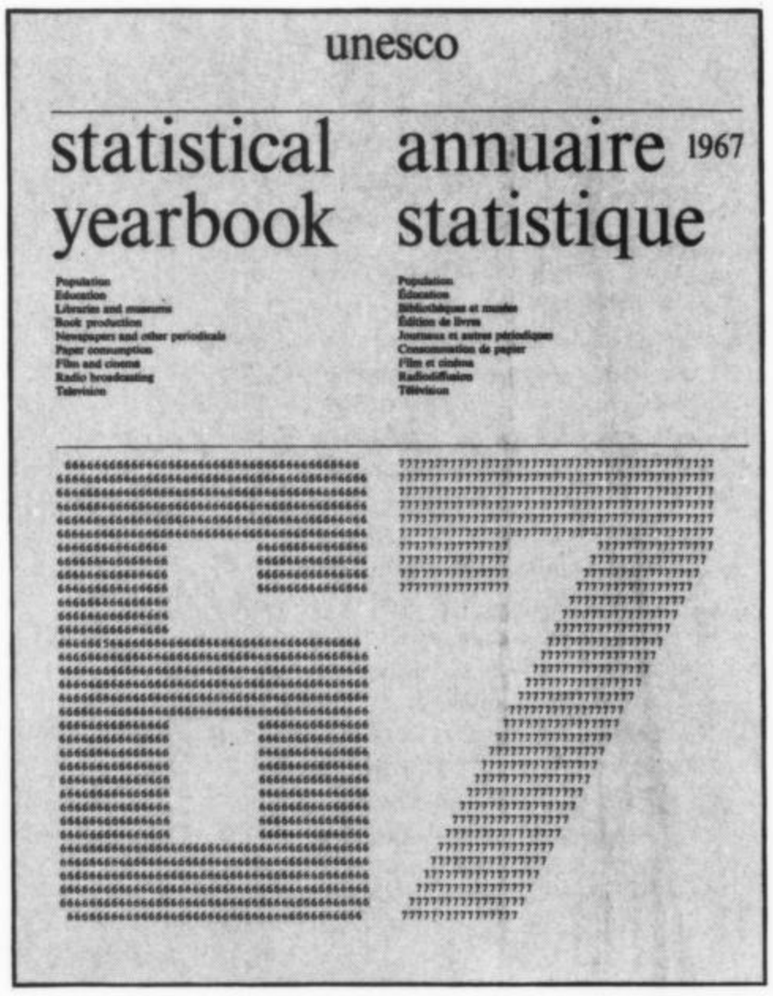

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THE BEAUTY OF A SEA-SHELL

Nature unmatched in artistry and genius is epitomized in the perfection of this spiral shell of a nautilus (here sectionalized). One of the most ancient of marine molluscs—150 million years old—the nautilus is found chiefly in the south Pacific. A plentiful source of food for man, the sea is equally a world of creatures in which Nature has allied perfect functional form to exquisite beauty (see photos page 18).

Photo : Andreas Feininger